THE PLANT DISEASE REPORTER

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THE PLANT DISEASE SURVEY

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The Plant Disease Reporter is issued as a service to plant pathologists throughout the United States. It contains reports, summaries, observations, and comments submitted voluntarily by qualified observers. These reports often are in the form of suggestions, queries, and opinions, frequently purely tentative, offered for consideration or discussion rather than as matters of established fact. In accepting and publishing this material the Division of Mycology and Disease Survey serves merely as an informational clearing house. It does not assume responsibility for the subject matter.

PLANT DISEASE REPORTER SUPPLEMENT

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THE PLANT DISEASE SURVEY
DIVISION OF MYCOLOGY AND DISEASE SURVEY

Plant Industry Station Beltsville, Maryland

STUDIES ON VEGETABLE SEED TREATMENTS IN 1944

Report by Vegetable Seed Treatment Sub-Committee
of the Seed Treatment Committee of the
American Phytopathological Society

Plant Disease Reporter
Supplement 161

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I. SCOPE OF 1944 TEST AND FUTURE PLANS

C. M. Haenseler

Cooperative Tests in 1944

Cooperative vegetable seed treatment tests, started in 1940 under the direction of a committee appointed for that purpose by the American Phytopathological Society, were continued in 1944 for the fifth consecutive year. During 1944 data were obtained from a total of 236 individual tests conducted with 10 vegetable crops by 42 cooperators located in 30 States and 2 Canadian Provinces as listed in Table 1.

In each crop except onions, seeds from a single lot were treated with various seed protectants and distributed to the several cooperators who planted them in five replications of 100 seeds each for each of the treatments and an untreated check lot.

In most of the tests data on seedling emergence only were obtained but records on weak seedlings and on damping-off were included in a few cases. With onions the tests were of two types, one on seed decay and damping-off, the other on smut control.

Plans for the Future

At a meeting of the crop leaders held in Cincinnati during the Annual Convention of the American Phytopathological Society, December 1944, it was unanimously agreed that the type of cooperative tests conducted by our committee during the past five years should not be continued in 1945, and probably not soon thereafter. It was thought that the purpose for which the tests were originally planned had been largely accomplished. Large scale testing might well be resumed by the group, however, as soon as we have several new seed protectants which have been carefully studied by one or more individuals. These preliminary studies should establish the approximate dosage, dustability, phytotoxic properties, and ease of handling, before distribution to a large number of cooperators.

The committee recognized that many questions relating to seed treatment problems still remain unsolved but it was thought that most of these could be more efficiently studied by individuals than by large scale cooperative testing. Such problems as control of seed-borne diseases, effect of seed treatment on crop yield, and compatibility of certain seed protectants with legume inoculants, etc., require intensive study, whereas our large group of cooperators could be expected to conduct only simple tests which could be added to their regular program without serious interference with their own work.

After considering all these angles all of the crop chairmen agreed that it would be best to discontinue the cooperative vegetable seed treatment tests for the time being and to reorganize the group if desirable after preliminary tests conducted by various individual workers had revealed several new materials which seemed to have specific advantages over those so thoroughly tested during the past five years.

The committee hopes to function as a clearing house for the time being and will attempt to assemble miscellaneous information on new seed protectants from time to time. When several prospective materials have been tested locally and found to have specific advantages over the standard treatments the committee may again call on cooperators in the various states to give the new materials a thorough nation wide test. There may be sufficient data available on several new products to warrant a large scale cooperative test again in 1947 or possibly 1948.

Accomplishments To Date

The results obtained from the five years' cooperative test just concluded have gone far beyond their original intention, viz. comparison of the relative efficiency of several seed protectants for vegetable seeds. They have not only established the relative efficiency and the optimum dosages of the various seed protectants now commercially available for use on vegetable seeds, but they have had many other direct and indirect effects in addition. For example, they demonstrated that a large group of independent workers can cooperate advantageously in solving certain types of problems that lend themselves to this method of testing; they have encouraged the adoption of uniform interstate recommendations for vegetable seed treatments, a very significant accomplishment; they have greatly stimulated interest in vegetable seed treatments among growers; they have impressed seedsmen with the importance of seed treatment and have encouraged some of them to offer treated seeds to the trade. These accomplishments have made the cooperative tests of value not only to the seedsman and to the vegetable grower but also to the cooperators and we hope to the field of Plant Pathology as a whole.

We should like to thank each of the many cooperators and each of the various crop leaders and committee members who worked so well together to make these tests a success. They all deserve credit for the spirit in which they worked together toward a common goal. We know they will respond again if the need arises.

NEW JERSEY AGRICULTURAL EXPERIMENT STATION

Table 1. Cooperative vegetable seed treatment tests conducted in 1944.

Cooperator			Number of tests										
Serial no.	State	Name	Beets	Carrot	Cucumber	Lettuce	Onion	Pea	Soybean edible	Spinach	Sweet corn	Tomato	Total
1	Ark.	J. Ralph Shay								1			1
2	Calif.	L. D. Leach	1	1			1	2		1			6
3	Conn.	A. M. Porter	1	1	1		1			1	1	1	7
4	Del.	J. W. Heuberger						1		1	1		3
5	Fla.	A. N. Brooks								1	1		2
6	Fla.	W. B. Tisdale							1				1
7	Fla.	G. R. Townsend	1	1				2					4
8	Ga.	G. E. Thompson	2	1		1				2		1	7
10	Idaho	G. K. Knight					2	2		1			5
12	Ind.	C. M. Smith									1		1
13	Iowa	R. H. Porter	1	1				2	1		1		6
14	Md.	C. E. Cox	1		1	1	1	2		1	1	1	9
15	Md.	S. P. Doolittle & F. S. Beecher			1							1	2
16	Mass.	C. C. Boyd & B. T. Sproston					*1						1
17	Mass.	E. F. Guba & E. V. Seeler	1	1	1	1	1	2	1	1	1		10
19	Mich.	J. H. Muncie	1		1			2		1			5
20	Minn.	C. J. Eide	1	1				2		1	1		6
22	Neb.	M. W. Felton & A. E. Dimond	3								3		6
23	N. J.	B. H. Davis		1	1			2	1	1	1	1	8
24	N. Y.	W. T. Schroeder	1					4		1	1		7
25	N. Y.	F. M. Gordon	1	1		1			1	1	1	1	7
26	N. Y.	A. G. Newhall & W. Erader		1			1						2
27	N. C.	D. E. Ellis & M. F. Buell	1	1	1		1	2	1	1			8

Serial no.	State	Cooperator: Name	Number of tests: Beets	Carrot	Cucum-ber	Lettuce	Onion	Pea	Soybean edible	Spinach	Sweet corn	Tomato	Total
28	N. D.	W. E. Brenzel							1	1			2
29	Ohio	J. D. Wilson	2				1	2	1	2	1		9
30	Okla.	J. H. McLaughlin	3	3	1	2		4	1	3	3		20
31	Oreg.	F. P. McWhorter & P. W. Miller	1				*1			1			3
32	Pa.	W. S. Beach	1	1				2	1	1	1		7
33	Pa.	R. P. Porter			1				1	1	1	1	5
33.1	R. I.	F. L. Howard					1						1
34	S. C.	C. N. Clayton	1		1	1			1	1	1		6
35	S. C.	C. J. Nusbaum	1			1	1	2	1	1	1	1	9
36	S. D.	C. M. Nagel	1					2		1	1		5
38	Va.	G. K. Parris	2	1	3	1		5	2	3	3	2	22
39	Wash.	C. J. Gould		1	1				1				3
40	Wash.	L. K. Jones				1		2			1	1	5
41	W. Va.	J. G. Leach & C. F. Taylor			1			1	1	1		1	5
42	Wis.	J. E. Kuntze						2		1			3
43	Wis.	J. C. Walker	2	1				2		1			6
44	Wyo.	G. H. Starr						2		1	2		5
45	Canada	G. A. Scott & R. G. Atkinson						2		1	1		4
46	Canada	Irene Mounce	1	1									2
		Total number of tests	31	19	15	10	13	53	17	36	30	12	236

* Tests conducted on smut control

II. GARDEN BEET SEED TREATMENTS

L. D. Leach

Garden beet seed of the variety Detroit Dark Red was treated with Arasan at 3 different dosages and with Ceresan and Yellow Cuprocide at one dosage each and planted along with nontreated seed in 5 replications of 100 seedballs per row.

Thirty-one tests were completed by cooperators in 23 experiment stations and the results are presented in Tables 2 and 3. The 1944 tests are remarkable in that 25 out of the 31 tests showed significantly higher emergence from treated than from nontreated seed.

The best evidence of the effects of the different seed treatments is obtained by analyzing the combined data from the tests[1]. To produce a homogeneous group it is necessary to eliminate the following 5 tests: 43A because of high variance, and 8A, 27, 35 and 38B because of low variance. Two of these would also be eliminated because severe crusting of the soil prevented satisfactory emergence of the seedlings. The averages and statistical analysis for the 26 tests representing a homogeneous group are as follows:

Number of Tests	Average number of seedlings						Average error variance	"F" Value
	Arasan			Ceresan	Yellow Cuprocide	Non-treated		
	0.25%	0.5%	1.0%	1.0%	1.5%			
26	63.7	69.5	72.9	63.3	65.1	32.2	143.9	193.77

Significant difference 19:1 odds - 2.93; 99.1 odds - 3.86.

It is clearly evident that all treatments increased the emergence of beet seedlings significantly as compared with the nontreated. There is no significant difference between Arasan at 0.25%, Ceresan at 1.0%, and Yellow Cuprocide at 1.5%. Higher dosages of Arasan, 0.5% and 1.0%, were

[1]Roessler, E. B., and L. D. Leach. Analysis of combined data for identical replicated experiments. Proc. Amer. Soc. Hort. Sci. 44: 323-328, 1944.

Table 2. Location, time, and environmental conditions of garden beet seed treatment tests, 1944.

Test no.	Locality	Planting date	Soil conditions: Type	pH	Moisture	Precipitation	Air temperature: Max.	Min.	Days to emerge
						in.	°F	°F	
2	Calif.	2/14	Fine sandy loam	6.8	Optimum	3.01	58.6	35.2	15
3	Conn.	5/20	Sandy loam	6.2	Very wet	0	88.8	62.9	5
7	Fla.	2/19	Peat	6.2	Dry	0	86.3	55.0	6
8A*	Ga.	3/8	Sandy loam	5.6	Optimum	W	88.7	52.2	-
8B	Ga.	3/25	Cecil clay	5.7	Optimum	3.64	69.5	42.9	-
13	Iowa	4/17	Heavy	-	Very wet	-	-	-	-
14*	Md.	10/7	Sandy loam	5.6	Optimum	W	93.4	51.8	6
17	Mass.	4/18	Gravelly sandy loam	6.07	Optimum	1.96	62.6	34.6	-
19	Mich.	4/29	Sandy loam	7.2	Optimum	1.16	62.2	43.8	11
20	Minn.	5/15	Silt loam	5.5	Optimum	3.03	75.5	56.7	15
22A	Nebr.	5/1	Clay Loam	7.4	Optimum	1.33	70.0	50.2	-
22B	Nebr.	5/26	Clay loam	7.4	Dry	3.54	77.8	59.9	-
22C	Nebr.	8/7	Clay loam	7.2	Dry	1.24	90.8	68.4	-
24	N.Y.(G)	5/1	Silty clay loam	7.09	Dry	2.88	76.6	50.9	8
25	N.Y.(I)	5/10	Black sandy loam	6.15	-	0.48	75.9	58.9	5
27	N. Car.	4/7	Norfolk sandy loam	5.61	Wet	4.08	-	50.8	-
29A	Ohio	4/22	Silt loam	6.8	Wet	3.14	-	-	-
29B	Ohio	4/26	Muck	5.8	Optimum	-	-	-	-
30A	Okla.	3/24	Fine sandy loam	5.14	Optimum	0.38	63.6	38.9	-
30B	Okla.	3/25	Loam	6.17	Optimum	1.86	66.8	39.0	-
30C*	Okla.	3/26	Sandy loam	-	Wet	W	73.0	64.6	-
31	Oreg.	3/15	Clay loam	6.0	Dry	0.77	59.8	36.3	17
32	Pa.	4/29	Clay loam	7.0	Optimum	4.63	77.1	50.7	9
34	S.C.(Ch)	3/2	Sandy loam	5.1	Optimum	5.01	66.9	43.2	10
35	S.C.(Bl)	3/27	Sandy loam	5.72	Wet	1.48	62.9	43.1	7
36	S.Dak.	5/22	Barnes loam	6.5	Wet	0	81.5	54.7	-
38A	Va.	2/23	Loamy sand	5.85	-	7.13	57.1	37.9	17
38B	Va.	4/11	Sandy loam	6.2	Optimum	2.37	74.0	50.4	13
43	Wisc.	5/24	Silt loam	6.4	Optimum	2.92	81.9	64.2	-
46*	Can.(B.C.)	5/31	Compost	-	Optimum	W	83.9	53.9	-

* Planted in greenhouse; all others in field.

Table 3. Effect of seed treatment on emergence of garden beets.

Report from		Average number of seedlings per 100 seedballs						Signif- icant Differ- ence [a]	Calculated "F" value
Test no.	Locality	Arasan			Ceresan	Yellow Cuprocide	Non- treated		
		0.25%	0.50%	1.0%	1.0%	1.5%			
2	Calif.	63.2	50.0	58.2	57.8	52.4	25.0	14.17	8.03
3	Conn.	40.6	63.4	71.0	51.4	25.2	13.6	17.52	12.38
7	Fla.	48.8	52.0	50.6	45.8	43.0	24.0	12.24	6.22
8A	Ga.	64.0	63.0	65.4	69.0	64.0	52.0	7.42	5.19
8B	Ga.	29.0	31.8	21.8	18.0	13.8	8.8	11.82	4.84
13	Iowa	40.4	35.6	46.4	31.8	36.6	22.8	10.30	5.36
17	Mass.	99.6	102.6	109.6	87.8	113.6	30.6	17.74	26.14
19	Mich.	38.4	45.0	56.8	34.8	50.8	7.0	14.68	12.30
20	Minn.	39.0	58.4	43.2	41.0	35.0	14.6	13.8	9.25
22A	Nebr.	81.0	72.8	80.4	82.6	66.6	27.8	14.3	18.4
22B	Nebr.	48.2	43.4	49.6	45.0	37.0	14.4	17.5	4.9
24	N.Y.(G)	61.8	60.2	75.8	67.8	76.4	39.4	18.70	4.63
25	N.Y.(I)	72.4	89.0	104.6	68.0	89.8	23.8	14.47	32.97
29A	Ohio	50.4	56.2	60.8	53.2	47.4	32.4	10.02	8.35
29B	Ohio	59.8	72.0	71.2	49.6	56.2	34.2	18.81	4.96
30A	Okla.	85.8	89.2	95.6	81.4	85.6	41.0	17.46	9.39
30B	Okla.	82.2	73.8	72.6	75.4	72.2	46.6	15.31	5.57
30C	Okla.	111.8	133.6	132.4	125.6	123.0	19.6	16.85	58.94
32	Pa.	99.6	105.6	116.0	108.2	113.6	77.2	15.69	6.98
34	S.C.(Ch)	63.2	77.6	73.4	72.4	65.4	40.2	21.68	3.34
35	S.C.(Bl)	91.4	97.0	105.0	99.2	102.8	77.2	4.88	37.31
36	S. Dak.	52.4	75.2	79.0	38.2	76.0	40.6	13.04	18.01
38A	Va.	48.2	56.2	58.2	46.2	62.0	19.2	16.27	7.80
43B	Wisc.	40.6	37.2	36.6	31.8	34.4	16.6	15.64	4.82
46	Can.(B.C.)	131.4	133.8	137.0	135.6	130.8	61.6	15.19	32.8
Average Significant tests:		64.6	71.0	74.8	64.7	66.9	32.4		

Report from		Average number of seedlings per 100 seedballs						Significant Difference [a]	Calculated "F" value
Test no.	Locality	Arasan			Ceresan	Yellow Cuprocide	Non-treated		
		0.25%	0.50%	1.0%	1.0%	1.5%			
14	Md.	45.8	53.2	50.4	59.4	52.4	34.6	N.S.	1.39
22C	Nebr.	46.4	30.2	37.8	39.4	33.6	33.0	N.S.	1.8
27	N.Car.	9.2	12.4	13.4	8.6	13.6	2.4	N.S.	2.17
31	Oreg.	104.6	109.4	105.6	98.6	99.4	89.0	N.S.	1.72
38B	Va.	4.0	4.4	5.6	4.0	5.6	2.6	N.S.	0.5
43A	Wisc.	34.2	43.6	32.0	50.0	23.0	36.0	N.S.	0.99
Average Non-significant tests:		40.7	42.2	40.8	43.3	37.9	32.9		
AVERAGE ALL TESTS		60.0	65.4	68.2	60.6	61.3	32.5		

[a] Differences required for significance between means --- Odds 19 : 1.

significantly better than all other treatments. The 1.0% dosage of Arasan exceeded the 0.5% dosage at the 5% but not at the 1% level of significance.

The emergence from Ceresan-treated seed was significantly lower than from that treated with Arasan in 8 individual tests. The fact that in 7 of these tests the seed was planted 80 to 110 days after treating suggests that in some cases chemical injury to the seed during storage may have influenced the results. Delay of emergence was reported in one test each for seed treated with Ceresan and Yellow Cuprocide.

Only 6 cooperators reported the chief causal organism. Five found Pythium and one Rhizoctonia to be responsible for most of the infection in their tests.

The contrast between the 1943 and the 1944 cooperative tests is particularly noticeable. In 1943 only 2 out of 19 tests showed significant improvement in stand from seed treatment, while in 1944 with 6 of the same treatments, 25 out of the 29 tests in which conditions were satisfactory for germination showed significant improvements from seed treatment. On the average the 1944 tests were conducted at slightly lower temperatures and with somewhat more rainfall during the germination period than in 1943, but these factors do not appear to explain the results. Cooperators will remember that the information sheet accompanying the 1944 seed packets contained the following statement: "For the 1944 test a seed lot of Detroit Dark Red that appears highly susceptible to damping off and that shows a mean emergence period significantly longer than the 1943 seed lot has been selected."

In the writer's opinion the differences in vitality and susceptibility of the two seed lots are chiefly responsible for the difference in results of the two years. This opinion is supported by the similarity of the average of all cooperative tests and results obtained in tests under controlled conditions. The results, therefore, illustrate the important effect that quality of seed may exert in seed treatment tests.

Conclusions: In most of the tests conducted in 1944, seed treatment with Arasan, Ceresan, or Yellow Cuprocide significantly increased the emergence of Detroit Dark Red garden beets. Arasan at dosages of 0.5% and 1.0% gave the best results. Whether the differences between these two justify the use of the 1.0% dosage is not clear. The striking benefits from seed treatment in the 1944 tests in contrast to the limited benefits in 1943 are attributed chiefly to differences in vitality and susceptibility of the two seed lots.

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III. CARROT SEED TREATMENTS

B. H. Davis

Cooperative seed protectant tests were conducted on carrots for the first time in 1944. The following protectants and dosages were tested on the variety Chantenay: Arasan and Spergon at .5 and .75%, Semesan at .42%, and red copper oxide and zinc oxide at 1% by weight of seed. Data were received from 19 of the 22 lots of seed planted by 18 cooperators in 16 States and one Canadian Province. Of the 19 tests 8 showed significant differences between treatments at the 5% level. A summary of the environmental conditions in these 19 locations are given in Table 4 and a summary of the seedling counts and statistical significance are shown in Table 5.

An analysis of combined data produced a homogeneous group[1] if tests 38, 3, 39, and 26 are omitted. The averages and statistical analysis for the 15 tests follow:

No. of tests	Average number of seedlings								Average error Variance	"F" Value	L.D.S.*
	Arasan .5%	Arasan .75%	Spergon .5%	Spergon .75%	Semesan .42%	Red Copper Oxide 1%	Zinc Oxide 1%	Check			
15	25.9	27.1	24.1	23.3	22.4	24.5	22.7	20.3	30.67	9.00	2.0

* Least difference required for significance at 5% level.

In these 1944 tests seed treated with all the above protectants at the dosages indicated produced a significantly greater number of seedlings than the control. The best material was Arasan which at the .75% dosage was significantly better than all other materials and at the .5% dosage was better than all except red copper oxide, and Spergon at .5%. No significant difference was obtained between the two Arasan dosages. With the exception of red copper oxide which was significantly better than Semesan, no significant differences occurred between any of the other materials.

[1] Roessler & Leach, see page 6.

Table 4. Location, time and environmental conditions of cooperative carrot seed tests conducted in 1944

				Soil			Germination Period[b]		
Coop. no.	Locale	Planting date	Planted in*	pH	Moisture at planting	Type	Total precipitation	Mean air temperature Min. Max.	No. of days to emergence[a]
							in.	°F °F	
39	Wash.	4/1	F	5.5	Optimum	Sandy Loam	2.44	39-59	-
26	N. Y.	6/25	G Bed	5.7	Optimum	Muck	**	67-103	-
46	Canada	4/21	G	-	-	Compost	**	59-88	8
8	Ga.	3/11	Gard.	5.7	-	Cecil Clay	4.70	41-68	-
30A	Okla.	3/7	G Bed	7.14	Wet	Clay Loam	**	65-72	7
17	Mass.	4/26	F	6.07	Wet	Sandy Loam	.39	42-71	14
25	N. Y.	5/10	F	6.15	Optimum	Sandy Loam	.49	57-74	15
30B	Okla.	3/14	F	6.17	Dry	Loam	2.08	37-58	-
27	N. C.	4/7	F	5.61	Wet	Sandy Loam	4.08	51-75	-
30C	Okla.	3/24	F	5.14	Optimum	Sandy Loam	.26	38-63	-
13	Iowa	4/17	F	7.0	Wet	-	-	-	-
43	Wisc.	5/17	F	6.40	Optimum	Silt Loam	2.25	61-79	10
2	Calif.	9/4	F	6.8	Wet	Sandy Loam	-	58-99	10
3	Conn.	5/20	G Bed	6.2	Very Wet	Sandy Loam	-	64-85	8
20	Minn.	5/15	F	5.5	Optimum	Silt Loam	.99	56-74	-
38	Va.	2/23	F	5.85	Optimum	Sandy Loam	3.77	37-56	22
32	Pa.	5/16	Gard.	6.9	Optimum	Clay Loam	3.18	56-78	10
23	N. J.	5/1	F	5.25	Optimum	Sassafras Loam	1.97	56-78	15
7	Fla.	2/22	F	6.2	Dry	Everglades Peat	-	54-85	10

NOTE: * F-field; G-greenhouse; Gb-greenhouse benches; G Bed-greenhouse beds; Gard.-garden.

** Watered

a "No. of days to emerge" was taken as the time between planting and time when majority of seedlings had emerged.

b When sufficient data were supplied the "germination period" was arbitrarily considered as 50% longer than "number of days to emerge" in order to include data on moisture and temperatures during the period of post-emergence damping-off. In some cases the environmental data were supplied only to the time when the majority of seedlings emerged.

Table 5. Summary of cooperative carrot seed treatment tests analyzed as randomized block tests - 1944

Coop. no.	Locality	Arasan .5%	Arasan .75%	Spergon .5%	Spergon .75%	Semesan .42%	Red copper oxide 1%	Zinc oxide 1%	Check	Diff. req. for sign.[a]	Calculated "F" value
39	Wash.	14.6	7.0	14.4	3.2	11.6	6.8	2.8	1.6	3.20	25.87
26	N. Y.	47.6	54.8	49.2	46.8	52.4	52.0	49.4	50.0	2.38	10.40
46	Canada	54.0	52.4	45.8	47.6	36.0	44.0	35.4	35.8	6.74	10.32
8	Ga.	19.6	23.0	17.4	18.2	8.8	14.0	12.2	11.8	5.86	5.42
30A	Okla.	41.6	50.4	37.0	32.4	39.2	34.4	37.2	28.0	4.85	3.79
17	Mass.	40.4	42.2	41.8	40.0	39.0	44.8	45.2	30.8	7.07	3.40
25	N. Y.	39.4	48.8	33.2	30.0	33.6	36.8	35.8	35.0	9.48	2.98
30B	Okla.	26.8	29.8	26.0	24.4	23.8	23.4	16.6	18.6	8.04	2.39
27	N. C.	4.4	4.0	5.0	3.0	5.0	9.2	9.0	5.6	N.S.	1.65
30C	Okla.	22.6	25.2	17.8	25.0	17.6	22.8	18.8	17.2	N.S.	1.54
13	Iowa	16.0	15.4	14.2	18.6	14.4	17.0	16.8	9.2	N.S.	1.40
43	Wisc.	10.8	7.2	8.0	3.0	11.6	8.2	8.0	4.2	N.S.	1.38
2	Calif.	16.6	16.0	18.0	14.4	19.6	12.0	11.0	18.8	N.S.	1.10
3	Conn.	31.8	33.0	27.0	33.6	35.6	28.2	25.2	27.2	N.S.	1.05
20	Minn.	15.4	17.2	22.6	19.6	13.8	16.8	14.0	16.8	N.S.	.96
38	Va.	45.6	44.8	47.8	40.6	38.8	45.8	41.6	39.2	N.S.	.82
32	Pa.	41.4	42.4	39.8	39.0	41.2	44.4	43.6	38.0	N.S.	.56
23	N. J.	24.4	22.2	21.2	23.6	19.6	26.2	25.4	25.0	N.S.	.54
7	Fla.	15.2	10.4	14.2	11.0	13.2	13.6	11.4	9.6	N.S.	.47

a Least difference required for significance at 5% level.

Counts on post-emergence damping-off were made by three cooperators. Although the percentage of seedlings with damping-off was lowest in the Arasan treated plots, the data are too meager to draw definite conclusions. Further data on damping-off were furnished from one other test (No. 26, Newhall, N. Y.). Severe damping-off prevailed at the time the first counts were made. The significant differences between treatments reported for these counts were lost when a second count was taken 11 days later when all remaining plants appeared healthy.

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IV. CUCUMBER SEED TREATMENTS

S. P. Doolittle and F. S. Beecher

The cucumber seed treatment tests of 1944 were essentially a repetition of those of 1943 and were designed to test again the value of certain newer protectants as compared with others long in common use. A dust treatment with New Improved Ceresan was included because of some demand for a protectant that would also disinfect the seed surface. The use of New Improved Ceresan was suggested by recent work of B. H. Davis and A. M. Haenseler of the New Jersey Experiment Station, in which they showed the value of the New Improved Ceresan dust as a treatment for tomato seed.

The treatments used were: Arasan (0.3% by weight of seed); Yellow Cuprocide (1.0%); Spergon (0.3%); New Improved Ceresan (0.3%); Semesan (0.3%) and an untreated check. Seed of the variety "A and C" was used in the trials. Through the kindness of Mrs. Vivian K. Toole of the Bureau of Plant Industry, Soils, and Agricultural Engineering, tests of germination were made with seed samples from each treatment and the check, according to the rules of the Association of Official Seed Analysts. The tests were made during June 1944 and showed no significant differences in germination, the figures for the various samples ranging from 58.25 to 61.75 percent. It was evident that the seed used was low in germination, but it seemed possible that this might lead to more marked differences between protectant treatments.

The seed was treated at Beltsville, Maryland, and samples sent to the various cooperators. The tests were planted in 5 randomized blocks made up of 6 treatment plots of 100 seeds each. The data were recorded on the basis of total emergence.

Table 6 gives locations, time of planting, environmental conditions, and average number of days required for emergence of seedlings. The data on total emergence and their statistical significance are given in Table 7.

Table 8 shows the number of tests in which seedling emergence for any single treatment was significantly greater than that for any other treatment and indicates the relative value of the various treatments in this set of tests when compared in such a way.

Data were received for 16 trials conducted in 10 States. Five of these tests were conducted in the greenhouse and 11 in the field. One test was lost because of unfavorable conditions and 11 of the remaining trials did not show statistically significant differences. Three of the 4 significant tests had been planted in the greenhouse. In 1943, practically all of the tests, both in the field and greenhouse, showed significant differences and it would seem, therefore, that field conditions in 1944 were less favorable for damping-off.

Table 6. Location, time, and environmental conditions of cucumber seed treatment tests with the "A and C" variety in 1944

Report from: Test no.	State	Planting date	Soil conditions: Type	pH	Moisture	Rainfall	Air temperature: Min. - Max.	Days to emerge
						In.	°F °F	
3	Conn.	5/20	Sandy loam	6.2	Very wet	G.H.[a]	55 - 98	4
14	Md.	3/29	Sandy loam	5.6	Optimum	G.H.	38 - 94	9
15	Md.	4/10	Sandy loam	5.6	Optimum	G.H.	63 - 92	8
17	Mass.	6/1	Sandy loam	6.3	--	.94	39 - 88	9
19	Mich.	5/27	Sandy loam	7.2	Optimum	.92	45 - 85	--
23	N. J.	5/5	Sandy loam	5.8	Optimum	1.67	44 - 65	10
27	N. C.	4/1[illegible]	Sandy loam	5.61	Wet	1.41	38 - 84	10
30	Okla.	5/9	Loam	6.17	Optimum	G.H.	51 - 91	6
33	Pa.	7/19	--	--	Very dry	--	--	9
34	S. C.	3/22	Sandy loam	5.1	Wet	5.51	29 - 84	15-18
38A	Va.	8/6	Sandy loam	5.9	Optimum	4.49	58 - 98	--
38B	Va.	4/6	Loamy sand	6.7	Wet-Opt.	G.H.	61 - 106	4
38C	Va.	4/21	Sandy loam	6.2	Optimum	.61	41 - 89	10
39	Wash.	5/16	Sandy loam	5.5	Optimum	.80	34 - 87	--
41	W.Va.	--	Clay loam	6.75	Optimum	1.05	50 - 94	12

[a] G. H. refers to greenhouse test.

Table 7. Emergence data for cooperative cucumber seed treatment tests analyzed as randomized block tests, 1944

Report from: Test no.	State	Arasan 0.3%	Yellow Cuprocide 1.0%	Spergon 0.3%	New Improved Ceresan 0.3%	Semesan 0.3%	Untreated check	Least significant difference[a]	Calculated "F" value
		%	%	%	%	%	%	%	
14	Md.	23.0	30.0	24.4	33.0	30.0	14.4	9.64	4.24
15	Md.[b]	48.2	43.0	56.0	38.8	53.2	15.0	5.79	56.66
17	Mass.	51.8	55.2	62.0	56.2	59.8	46.4	7.57	4.78
19	Mich.	42.6	43.0	32.8	35.6	39.8	25.6	6.28	9.9
3	Conn.	52.0	45.0	48.8	45.0	44.8	43.0	NS	0.63
23	N. J.	47.2	43.4	43.2	36.8	47.2	40.6	NS	1.854
27	N. C.	18.2	11.8	11.6	9.8	11.6	3.4	NS	1.81
30	Okla.	48.2	49.4	44.0	46.0	43.2	43.4	NS	--
33	Pa.	37.2	34.2	36.4	30.0	30.8	24.8	NS	--
34	S. C.	19.2	22.6	28.4	32.6	23.2	19.6	NS	2.45
38A	Va.	23.2	25.0	19.4	21.2	21.2	19.8	NS	0.56
38B	Va.	56.2	59.0	55.6	60.8	56.4	53.4	NS	1.9
38C	Va.	40.8	43.2	41.0	42.6	40.6	28.2	NS	1.06
39	Wash.	8.6	9.2	9.4	6.0	5.6	3.4	NS	1.74
41	W.Va.	9.2	9.4	10.0	9.8	10.2	8.2	NS	--

[a]At 5% point

[b]Soil known to be infested with *Pythium* spp.

Table 8. Relative value of different protectants in improving emergence from cucumber seed, 1944

Treatment used	Number of times a given treatment (Column 1) was superior to						Total[a] score
	Arasan	Yellow Cuprocide	Spergon	New Improved Ceresan	Semesan	Untreated Check	
Arasan	-	-	1	2	-	2	5
Yellow Cuprocide	-	-	1	1	-	4	6
Spergon	2	1	-	1	-	4	8
New Improved Ceresan (dust)	1	-	-	-	-	4	5
Semesan	1	1	1	1		4	8
Untreated check	-	-	-	-	-	-	0

[a] Maximum value 20

Some of the 1944 tests classed as non-significant show considerable differences in the means for certain treatments. Individual comparisons of a number of such differences within the individual tests have shown that in occasional instances they are statistically significant, although the great majority are not. The results of these comparisons did not affect the relative ratings of treatments as shown in Table 8.

In 2 of the 4 tests showing significant differences in emergence data, all treatments were significantly better than the untreated checks. In the remaining 2 tests, 4 of the 5 treatments were superior to the check. Differences in total scores of the treatments indicated that Semesan and Spergon were the most effective materials in 1944. Arasan, which in 1943 seemed definitely superior to other treatments, did not give particularly good results in the 1944 trials, while Spergon proved much more effective than in 1943. The treatment with New Improved Ceresan dust gave significantly better emergence than the checks in all 4 trials, but frequently was not so effective as certain other treatments. The value of this treatment for cucumbers can only be determined by further work.

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V. LETTUCE SEED TREATMENTS

G. K. Parris

During 1944, the following chemical seed treatments were tried on lettuce: red copper oxide (2% by weight), zinc oxide (2%), Semesan (0.2%), Arasan (2%), and Spergon (2%). Ten sets of data from 9 cooperators located in 8 states were submitted for summation and analysis. Five cooperators reported significant differences between treatments.

The data given in Table 9 indicate the geographical location and the key number of each cooperator, and the prevailing environmental conditions for each test.

In Table 10 are given the 10 tests, arranged in order of their respective error variances, and the mean percent seedlings emerged per treatment. To these data have been applied an analysis designed by Roessler and Leach (see footnote, page 6) which applies the chi-square test to determine the homogeneity of data from different locations. Four tests, (numbers 40, 35, 25, and 30B) with low error variances fall into homogeneous group 1, four other tests (14, 38, 34, and 8) form homogeneous group 2, while tests 17 and 30A stand apart and distinct from each other, having still higher error variances.

Emergence

The least difference necessary for significance between the means of Group 1 is 3.5 seedlings (Table 11). Thus all seed treatments are significantly better than the control. Red copper oxide (2%) is the best treatment while Semesan is the poorest, but there is no significant difference between the copper oxide and Spergon, or between the copper oxide and Arasan.

In Group 2, the least difference necessary for significance is 6.0 seedlings. Here, unlike findings in Group 1, red copper oxide is of no benefit over the control, which is likewise true of Semesan and Arasan. Spergon continues to be significantly better, but is no better than the also significant zinc oxide treatment.

Tests 17 and 30A may now be considered. In both, significant differences between treatments were found by the respective cooperators; in test 17, Spergon, zinc oxide, and red copper oxide increased seedling emergence by significant amounts, but there was no significant difference between the 3 treatments, and in test 30A all treatments except zinc oxide increased emergence over the control, but none of the others was better than any other treatment.

Table 9. Location, time and environmental conditions of lettuce seed treatment tests - 1944.

Report from		Planting date	Planted in [a]	Soil conditions		Rainfall inches	Average temperature °F		Soil type
Test no.	Locale	1944		pH	Moisture		Min.	Max.	
8	Ga.	4/3	G. B.	5.6	Optimum	Irrigation	39	94	Sandy loam
14	Md.	3/4	G. B.	-	Optimum	Irrigation	47	81	Loam
17	Mass.	4/20	Field	6.0	Optimum	2.16	37	63	Merrimac gravelly sandy loam
25	N. Y.	5/10	Field	6.1	Optimum	0.50	56	74	Black sandy loam
30A	Okla.	3/9	G. B.	7.1	Wet	Irrigation	65	71	Loam
30B	Okla.	3/14	Field	6.1	Dry	2.08	37	61	Loam
34	S. C.	3/3	Field	5.1	Optimum	4.83	43	67	Sandy loam
35	S. C.	3/27	Field	5.7	Wet	1.55	44	63	Portsmouth sandy loam
38	Va.	2/24	Field	5.8	Optimum	4.42	35	53	Loamy sand
40	Wash.	3/21	G. B.	5.6	Optimum	Irrigation	50	70	Palouse loam and plat

[a] G. B. = greenhouse bench or flat

Table 10. Summary of lettuce tests analysed separately as randomized block experiments.

Cooperator no.	Locale	Mean percentage seedlings emerged: Red copper oxide 2%	Zinc oxide 2%	Semesan 2%	Arasan 2%	Spergon 2%	Check	Error variance (vi)	Log Vi
40	Wash.*	86.2	82.8	81.8	84.6	89.0	70.0	21.6	1.3345
35	S. C.*	65.0	52.0	58.0	57.4	54.6	49.6	27.1	1.4330
25	N. Y.*	79.8	71.8	72.2	64.8	78.0	65.4	35.3	1.5478
30B	Okla.	14.2	23.6	12.4	18.2	17.6	12.4	47.9	1.6803
14	Md.	83.2	78.0	78.8	77.2	83.6	72.4	78.6	1.8954
38	Va.	89.6	90.0	80.2	84.8	88.0	82.8	84.7	1.9279
34	S. C.	61.4	71.8	68.6	73.4	71.6	58.2	93.7	1.9717
8	Ga.	70.8	78.2	67.6	67.4	82.4	74.0	111.8	2.0483
17	Mass.*	65.6	62.2	48.0	56.6	74.6	42.0	128.4	2.1086
30A	Okla.*	61.8	40.8	53.8	69.6	55.8	21.0	296.2	2.4716
Totals	-	-	-	-	-	-	-	925.3	18.4191

*Significant difference between treatments

Table 11. Averages for data (given in Table 2) separated into 2 homogeneous groups.

Group	Number of locations	Red copper oxide 2%	Zinc oxide 2%	Semesan 0.2%	Arasan 2%	Spergon 2%	Check	Average error variance	Least difference for significance
1	4	61.3	57.5	56.1	53.7	59.8	49.3	32.9	3.5
2	4	76.2	79.5	73.8	75.7	81.4	71.8	92.8	6.0
Test 17	1	65.6	62.2	43.0	56.6	74.6	42.0	-	14.8
Test 30A	1	61.8	40.8	53.3	69.6	55.8	21.0	-	22.7

Post-emergence Damping-off

Two cooperators reported the presence of post-emergence damping-off. However, no significance could be attached to the data, less seedlings dying in check rows than in rows from treated seed.

Summary

Seed treatment seems to be a worthwhile procedure for lettuce. Spergon (2%) treated seed shows the most consistent benefits over untreated seed of the treatments tried in 1944.

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VI. ONION SEED TREATMENTS

A. G. Newhall

Damping-Off Control

Eleven tests for damping-off control and two for smut control were conducted by cooperators in 11 States. Yellow Globe onion seed was treated for the damping-off control tests by shaking in a flask with the following fungicides, each at two dosage rates as indicated (weight basis): Arasan 1 and .5%; Fermate 1 and .5%; Red Copper Oxide 1 and .5%; Spergon 1 and .5%; Semesan .5 and .3%; and Vasco 4, 3 and 1%. The cooperators counted out and sowed 100 seeds for each of 6 replications for each treatment and check. Some tests were made outdoors and some in greenhouses, as indicated in Table 12. In Ohio sufficient seed was treated to permit its being sown with a drill, in which case yield records rather than stand counts were obtained. In all other cases seedling stands were recorded 2 to 6 weeks after sowing. A summary of these counts is given in Table 13 as testimony to the value of the treatments. The relative values of the treatments are given in Tables 14 and 15. In 5 out of the 11 tests significant differences were obtained, 2 of these being greenhouse trials. The 6 failures to obtain significant differences might have been due to lack of inoculum or in some cases to unfavorable soil temperatures (California, Idaho).

From a study of the combined data from 4 tests showing significant differences (Table 13) it appears (a) that for damping-off control both levels of Arasan, Fermate, and Semesan were better than the checks and the other treatments, (b) that there was no difference between these three, and (c) that treatments with Spergon, Red Copper Oxide, and Vasco 4 were not significantly better than the checks. In one greenhouse test (Maryland) the higher dosage levels may have given slightly better results than the lower, but in the dry sandy soil of Long Island the opposite was very definitely true, so that on the whole there seems little reason for recommending the higher dosages until further evidence is secured.

Costs as computed by Gordon for treating 100 pounds of seed are said to be: Arasan at .5% - 64 cents; Semesan at .3% - 68 cents; Fermate at .5% - 35 cents. The black color of Fermate is believed by some to be handicap enough to offset its lower price. The effectiveness, favorable color, and safety of Arasan compel the writer to make it his first choice where the danger from damping-off is great enough to warrant a seed treatment for onions. Data in Table 16 seem to emphasize the value of this choice where part of the benefits from smut control may be due to damping-off control.

Table 12. Location, time, and environmental conditions of onion damping-off control tests 1944.

Coop. No.	Locality	Significance of data*	Date Sown	Date Data taken	Place	Soil	pH	Average air temperature	Moisture	Days to emerge
25	N. Y.	S	5/5	5/21	Field	Dry sand	5.8	65°	1.5 in.	12
33.1	R. I.	S	4/24	5/10	G'hs	Rich loam	-	-	Wet daily	-
14	Md.	S	5/15	5/24	G'hs	Sandy loam	5.6	75°	Optimum	10
27	N. Car.	S	4/7	5/2	Field	Sandy loam	5.6	-	Wet	-
29	Ohio	S	-	-	Field	Muck	-	-	-	-
17	Mass.	NS	4/28	6/5	Field	Gravelly sandy loam	6.05	58°	0.33	-
2	Calif.	NS	9/4	9/19	Field	Fine sandy loam	6.08	75°	Irrig.	-
3	Conn.	NS	-	-	-	-	-	-	-	-
10A	Idaho N.	NS	5/3	6/6	Field	Silt loam	6.9	43°	Too wet	22
10B	Idaho C.	NS	5/20	-	Field	Clay	alk.	cool	Too wet	22
35	S. Car.	NS	3/27	4/21	Field	Sandy loam	5.72	51°	Too moist	12

* S - Significant
NS - Non-significant

Table 13. Damping-off control: effect of various seed treatments on stand of onion seedlings (10 tests) and on yield (1 test)

Material and dosage	Mean Stands for 4 Significant Tests				Mean Stands for 6 Non-Significant Tests						Mean bu. per acre from one test
	Coop. #25 N. Y.	Coop. #33.1 R. I.	Coop. #14 Md.	Coop. #27 N. C.	Coop. #2 Calif.	Coop. #17 Mass.	Coop. #3 Conn.	Coop. #10A Idaho	Coop. #10B Idaho	Coop. #35 S. C.	Coop. #29 Ohio
Check	54.6	57.3	70.3	17.5	49.2	72.7	36.2	53.2	31.17	78.5	630
Arasan 1%	51.6	84.0	77.2	19.3	49.8	79.2	36.4	52.0	35.7	79.0	727
0.5%	60.8	80.1	74.1	24.2		76.3	35.6	49.7	23.2	80.1	704
Fermate 1%	59.0	80.7	72.5	24.3	48.8	78.2	41.6	50.3	29.8	79.5	496
0.5%	63.5	82.7	71.8	15.2		77.8	31.6	48.8	33.8	73.0	504
Spergon 1%	30.5	69.2	59.2	26.5	40.8	76.2	36.0	54.2	38.7	79.0	770
0.5%	36.0	61.7	62.6	21.2		76.3	34.4	50.7	34.8	78.1	726
Red copper oxide											
1%	40.0	61.2	60.3	32.8	44.8	76.0	13.4	54.3	33.7	76.5	718
0.5%	50.0	70.5	66.5	18.3		74.5	17.4	52.3	35.5	79.6	721
Semesan 0.5%	52.6	74.2	79.5	23.7	42.2	81.8	24.8	51.3	36.8	78.6	762
0.3%	59.8	72.2	74.5	24.8		72.7	36.2	55.2	41.2	77.6	727
Vasco 4, 3%	46.0	63.7	74.5	23.2	54.8	76.2	26.6	43.8	37.0	77.8	710
1%	59.3	67.8	65.7	20.5		75.2	19.8	52.0	36.7	78.5	685
F value	9.6	6.74	2.72	2.31	.827	1.1	2.10	.70	.80	.56	-
Least significant difference 5%	8.68	5.80	10.87	8.44							73
1%	11.55	13.14	14.29	11.23							
Error variance	67.00	73.27	92.42	53.52		33.183	181.696	36.894	95.793	10.000	

Table 14. Onion damping-off control: number of times each treatment significantly exceeded others in the 4 tests which showed significant differences.

Arasan		Fermate		Semesan		Red Copper Oxide		Vasco 4		Spergon		Check
.5%	1.%	.5%	1.%	.3%	.5%	.5%	1.%	1.%	3.%	.5%	1.%	
23	19	21	15	14	14	7	11	8	6	0	6	4

Maximum possible = 48

Table 15. Onion damping-off control: number of times each treatment exceeded others in the 5 comparable tests which nevertheless showed no significant differences.

Arasan		Semesan		Spergon		Fermate		Vasco 4		Red Copper Oxide		Check
.5%	1.%	.3%	.5%	.5%	1.%	.5%	1.%	1.%	3.%	.5%	1.%	
30	43	33	35	18	44	13	35	18	23	20	21	25
73		68		62		53		46		41		

Maximum possible = 60 for any single treatment level, 120 for a pair.

Table 16. Onion smut control treatments: effect of seed treatments and standard liquid formaldehyde row treatment on mean number of smutted seedlings (tests 31 and 16a) and on mean stand of seedlings (test 16b).

Coop. no.	Locality	Treatment								F value	L S Difference	
		Check	Arasan 100%	Arasan 75%	Fermate 100%	Fermate 75%	Thiosan 100%	Thiosan 75%	Formaldehyde 1/100 at 15 cc per foot		5%	1%
31	Oreg.*	62.3	14.3	15.3	21.2	16.7	20.2	21.3	10.5	39.+	7.6	10.2
16a	Mass.	54.8	2.4	4.4	6.6	7.2	5.2	7.2	0.6	27.+	6.7	9.1
16b	Mass.**	224	318	305	264	280	245	255	188	10.81	37.0	41.0

* Data given as percentage of total emerged.
** Partly damping-off control.

Smut Control

Yellow Globe seed was moistened with a 5% "methocel" sticker solution and then shaken together with the fungicide in an electric paint can shaker for 5 minutes or until each seed was thoroughly coated. The fungicides and treatment levels on a weight basis were as follows: Arasan 100% and 75%, Fermate 100% and 75%, and Thiosan 100% and 75%. In addition to these treatments and the check, the cooperators employed the standard formaldehyde drip (1% commercial formalin solution at 15cc per foot of row) at the time of sowing the 6 replicates.

Data were obtained from 2 of the 4 cooperators. In Oregon the test was made with 6 100-seed replicates in a greenhouse bench, while in Massachusetts it was outdoors in clay soil with 520 seeds in each of 5 replicates. In both tests (see Table 16) all treatments were infinitely better than no treatment. Formaldehyde was the best, though its superiority does not meet the 5% level of significance, except in the greenhouse test where it was much better than Thiosan and one of the Fermates. In both tests the higher rate of application gave better control than the lower, although the difference was not always a significant one. The price of Fermate has been in its favor but its color is much against its adoption by muckland onion growers. Incidentally, over two tons of onion seed were treated with Thiosan 100% in New York State in 1944 and the outlook is for 5 times as much in 1945.

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VII. PEA SEED TREATMENTS

W. T. Schroeder

Enough pea seed of the variety Thomas Laxton was treated to provide 5 replications of 100 seeds from each treatment for 76 tests by cooperators in 26 States and in one Province in Canada. The seed was furnished gratis by Crites-Moscow Growers, Inc. The following treatments were made in a rotary seed treater: Red Cuprocide at 0.251% (2 1/4 oz. per bu.), Arasan and Spergon at 0.167% (1 1/2 oz. per bu.), and Arasan and Spergon at 0.223% (2 oz. per bu.), by weight. Samples of each treated lot were submitted to the seed laboratory of the New Jersey Agricultural Experiment Station for germination tests and the results are as follows: Check - 98.0 percent; Red Cuprocide (0.251%) - 98.0 percent; Arasan (0.167%) - 98.5 percent; Arasan (0.223%) - 98.5 percent; Spergon (0.167%) - 98.0 percent; Spergon (0.223%) - 98.0 percent. All tests, except No. 30, were conducted under field conditions.

Shortages of time and labor resulted in the collection of total emergence data from only 53 tests in 23 States and "strong plants" data from 37 tests in 15 States. All data were analyzed as individual randomized block tests and as combined tests based upon the homogeneity of error variances (method of E. B. Roessler and L. D. Leach). The locations; planting dates; soil type and reaction; moisture condition of seed bed; precipitation; minimum, maximum, and mean air temperatures from planting to average date of emergence; and average number of days to emerge are set forth in Table 17.

Total Emergence

Total emergence varied widely in the different locations, ranging from 8.2 percent, to 96.4 percent in the checks. Significant differences in emergence occurred in 32 (61 percent) of the 53 individual tests, as indicated in Table 18. On the basis of all tests, the average emer ence of all treatments was 81 percent compared to 63 percent for the checks.

The emergence data from the four group analyses are given in Table 19. All treatments are significantly better than the checks in Groups I, II, and III; no significant differences occurred in Group IV. The number of individual tests in the 3 significant groups represents 94 percent of the total number of tests. In Group I, Spergon at 0.223% is better than Arasan at 0.167%. In Group II, Spergon at 0.223% is better than Red Cuprocide at 0.251% and Arasan at 0.167% and 0.223%; Spergon at 0.167% is better than Red Cuprocide at 0.251% and Arasan at 0.167%; Arasan at 0.223% is better than Red Cuprocide. In Group III,

Table 17. Planting data relative to the 1944 pea seed treatment tests.

Test no.	Location	Planting date	Soil: Type	Soil: pH	Moist. cond. seed bed	Precipitation	Air temperature: Min. °F	Air temperature: Max. °F	Air temperature: Mean °F	Days to Emerge
2A	Calif.	4/15	Fine sand loam	7.20	Wet	0.00	44	73	59	11
2B	Calif.	4/28	Fine sand loam	7.20	Optimum	1.19	51	79	65	10
4	Del.	4/15	Silt loam	?	Optimum	4.64	40	62	51	16
7A	Fla.	3/17	Muck	6.00	Dry	0.08	62	87	75	7
7B	Fla.	3/30	Muck	6.00	Optimum	2.08	57	80	69	6
10A	Idaho	4/5	Silt loam	6.90	Optimum	2.78	36	53	45	23
10B	Idaho	4/28	Silt loam	6.90	Wet	--	-	-	-	-
13A	Iowa	4/17	--------	7.00	--	--	-	-	-	-
13B	Iowa	4/28	--------	7.00	Optimum	--	-	-	-	-
14A	Md.	3/15	Loam	6.30	Optimum	2.23	35	55	45	23
14B	Md.	3/28	Loam	5.50	Wet	2.42	39	61	50	19
17A	Mass.	4/18	Gravelly sand loam	6.00	Wet	1.96	32	59	46	15
17B	Mass.	4/28	Gravelly sand loam	6.00	Optimum	0.00	41	73	57	10
19A	Mich.	4/29	--------	7.20	Optimum	1.15	44	63	54	9
19B	Mich.	5/8	--------	7.20	Optimum	1.97	50	70	60	9
20A	Minn.	5/15	Silt loam	5.50	Optimum	0.85	54	71	63	8
20B	Minn.	5/20	Silt loam	5.30	Wet	0.29	57	75	66	6
23A	N. J.	4/11	Loam	6.00	Optimum	3.94	39	59	49	14
23B	N. J.	4/19	Loam	6.30	Optimum	3.22	42	64	53	12
24A	N. Y.	4/29	Silt loam	7.02	Dry	2.53	49	76	63	11
24B	N. Y.	5/4	Silt loam	7.56	Wet	2.72	51	76	64	10
24C	N. Y.	5/12	Silt loam	7.07	Optimum	0.37	-	-	-	9
24D	N. Y.	5/15	Silt loam	7.82	Optimum	0.76	-	-	-	9
27A	N. C.	4/6	Sand loam	5.61	Wet	--	-	-	-	-
27B	N. C.	4/12	Sand loam	5.61	Optimum	--	-	-	-	-

29A	Ohio	4/26	Muck	5.80	Optimum	--	-	-	-	-
29B	Ohio	4/22	Silt loam	6.50	Wet	--	-	-	-	-
30A	Okla.	3/26	Sand clay loam	7.14	Wet	Watered	65	71	68	5
30B	Okla.	3/9	Loam	6.17	Optimum	1.88	39	61	50	15
30C	Okla.	3/14	Loam	6.17	Dry	2.08	36	61	49	18
30D	Okla.	3/24	Fine sand loam	5.14	Optimum	--	-	-	-	-
32A	Pa.	4/19	Clay loam	7.00	Optimum	2.60	40	60	50	11
32B	Pa.	4/30	Clay loam	7.00	Optimum	3.72	52	77	65	7
35A	S. C.	3/27	Sand loam	5.72	Wet	1.48	43	61	52	10
35B	S. C.	4/3	Sand loam	5.72	Optimum	0.04	46	69	58	8
36A	S. D.	5/24	Loam	6.50	Wet	0.26	56	81	69	6
36B	S. D.	5/29	Loam	6.50	Wet	--	-	-	-	-
38A	Va.	2/17	Sand loam	5.90	Wet	11.88	40	60	50	53?
38B	Va.	2/17	Sand loam	5.90	Wet	11.88	40	60	50	53?
38C	Va.	2/14	Sand loam	5.35	Very wet	12.31	40	61	51	61?
38D	Va.	3/25	Sand loam	5.35	Very wet	3.64	47	71	59	32
38E	Va.	9/13	Sand loam	5.80	Optimum	5.71	68	82	75	10
40A	Wash.	5/17	Loam	7.20	Dry	0.57	-	-	-	-
40B	Wash.	5/17	Loam	7.20	Dry	0.57	-	-	-	-
41	W. Va.	5/23	Clay loam	6.75	Optimum	0.30	60	90	75	9
42A	Wis.	5/24	Silt loam	6.20	Optimum	0.50	-	-	-	8
42B	Wis.	6/3	Silt loam	6.20	Dry	0.50	-	-	-	9
43A	Wis.	5/2	Silt loam	6.40	Optimum	0.91	50	65	58	10
43B	Wis.	5/16	Silt loam	6.40	Optimum	1.22	58	75	67	9
44A	Wyo.	5/1	Sand clay loam	7.50	Optimum	0.16	34	60	47	18
44B	Wyo.	5/19	Sand clay loam	7.50	Optimum	1.02	39	63	51	16
45A	Canada	5/23	Sand loam	5.20	Dry	0.05	55	82	69	6
45B	Canada	5/29	Sand loam	5.20	Dry	0.91	54	78	66	8

Table 18. Summary of individual tests with Thomas Laxton pea on total emergence, analyzed as randomized block tests (arranged according to the four groups of the combined analyses).

Test No.	Location	Check	Red Cuprocide 0.251%	Arasan 0.167%	Arasan 0.223%	Spergon 0.167%	Spergon 0.223%	Calculated F value	MSD (19:1)
13A	Iowa	89.4	97.4	95.8	95.2	96.2	97.2	4.25	4.33
13B	Iowa	94.4	92.2	95.8	96.8	95.4	96.8	1.98	N.S.
14A	Maryland	93.4	96.8	98.0	98.0	97.4	97.0	4.66	2.35
17A	Mass.	93.0	94.0	95.8	95.8	95.8	97.6	2.93	2.78
23A	N. J.	89.8	93.6	89.8	90.4	91.0	91.0	1.62	N.S.
23B	N. J.	93.6	95.4	94.0	96.8	96.2	96.2	2.28	N.S.
24D	N. Y.	96.4	98.0	93.6	96.8	94.8	95.8	2.44	N.S.
29A	Ohio	87.2	94.4	91.0	92.2	96.2	92.4	4.50	4.0
32A	Pa.	83.4	93.6	94.2	94.8	96.0	96.4	15.70	3.6
32B	Pa.	94.8	96.6	95.4	96.8	95.2	95.6	0.73	N.S.
44B	Wyo.	96.0	93.6	96.2	95.2	95.6	97.2	0.69	N.S.
45A	Canada	95.0	95.2	98.0	96.2	95.2	96.4	0.69	N.S.
10A	Idaho	87.0	93.2	94.0	92.4	97.2	95.0	3.29	10.12
14B	Maryland	55.8	90.2	86.4	90.6	91.6	96.0	57.07	5.73
17B	Mass.	82.6	86.4	85.2	74.8	85.4	77.8	5.07	6.69
19A	Michigan	72.4	93.8	93.4	95.4	95.0	95.4	2.97	4.92
20A	Minn.	74.2	91.2	89.0	90.0	92.2	91.6	15.96	5.10
20B	Minn.	67.4	86.4	80.0	79.8	82.8	86.0	6.48	8.10
24A	N. Y.	84.0	89.2	91.0	94.0	89.4	93.2	4.38	5.06
24B	N. Y.	61.6	78.0	86.2	88.8	84.6	86.8	16.20	7.48
24C	N. Y.	90.0	90.6	95.0	94.6	92.6	95.2	1.36	N.S.
29B	Ohio	80.4	92.8	88.0	92.4	93.6	95.2	11.40	4.80
30B	Okla.	88.6	96.2	96.6	97.0	95.4	95.4	3.45	4.98
30C	Okla.	81.6	91.8	95.4	93.0	94.2	96.0	11.78	4.57
30D	Okla.	57.4	89.0	88.6	94.0	92.2	92.6	51.09	5.77
35A	S. C.	72.0	82.0	82.2	87.8	90.2	91.2	9.65	6.79

35B	:S. C.	: 82.0	85.4	90.0	86.2	87.4	91.8 :	4.31 :	4.94
36A	:S. Dak.	: 80.0	87.2	85.4	85.8	87.4	83.4 :	1.58 :	N.S.
36B	:S. Dak.	: 57.0	85.8	76.0	79.8	82.8	89.0 :	17.97 :	3.81
38A	:Va.	: 47.6	92.2	91.8	96.4	94.2	93.0 :	104.70 :	5.40
38B	:Va.	: 81.2	94.2	93.2	94.4	95.8	96.0 :	8.30 :	5.60
40A	:Wash.	: 78.0	79.0	81.8	81.8	85.0	87.0 :	1.41 :	N.S.
41	:W. Va.	: 83.6	88.4	90.8	89.0	90.8	91.8 :	2.80 :	5.21
42B	:Wis.	: 74.2	85.2	85.4	89.2	86.0	88.0 :	5.79 :	3.13
43A	:Wis.	: 30.8	75.6	77.6	83.4	82.8	82.8 :	7.93 :	6.88
43B	:Wis.	: 27.4	70.4	74.6	78.2	72.2	79.0 :	153.00 :	4.69
44A	:Wyo.	: 88.6	92.0	92.2	92.8	92.6	94.8 :	1.29 :	N.S.
45B	:Canada	: 93.8	89.8	97.2	94.2	98.2	97.6 :	2.09 :	N.S.
2A	:Calif.	: 20.0	48.5	30.3	52.5	47.5	52.0 :	8.34 :	11.28
4	:Del.	: 36.4	70.0	74.0	80.4	79.4	87.4 :	34.80 :	9.10
10B	:Idaho	: 60.8	63.6	63.4	63.4	59.2	62.6 :	1.44 :	N.S.
19B	:Mich.	: 19.4	66.0	50.8	63.6	68.4	72.8 :	24.50 :	4.61
27A	:N.C.	: 23.2	39.0	28.6	27.8	28.6	34.2 :	2.28 :	N.S.
27B	:N.C.	: 12.0	49.8	36.4	40.6	54.2	64.2 :	23.46 :	10.99
30A	:Okla.	: 14.8	71.6	83.4	92.0	87.4	85.4 :	36.22 :	14.23
38C	:Va.	: 82.6	87.4	90.8	93.2	92.6	88.0 :	1.60 :	N.S.
38D	:Va.	: 82.6	86.4	89.6	89.6	89.2	92.4 :	0.50 :	N.S.
38E	:Va.	: 8.2	60.8	49.6	60.8	60.1	75.0 :	28.60 :	12.70
40B	:Wash.	: 70.6	78.4	80.6	85.8	79.0	84.4 :	2.56 :	N.S.
42A	:Wis.	: 91.0	85.2	88.8	88.8	85.8	87.6 :	0.37 :	N.S.
2B	:Calif.	: 34.2	42.2	43.6	50.0	56.4	52.0 :	1.60 :	N.S.
7A	:Fla.	: 61.0	72.6	66.2	79.4	49.8	68.4 :	2.20 :	N.S.
7B	:Fla.	: 60.8	73.2	55.4	70.8	75.4	83.4 :	1.14 :	N.S.
	Average	: 62.91	79.66	78.58	81.27	81.09	83.15		

Table 19. Summary of group analyses of total emergence tests with Thomas Laxton pea - 1944.

Group	No. tests	Average emergence from seed treated with: Check	Red Cuprocide .251%	Arasan .167%	Arasan .223%	Spergon .167%	Spergon .223%	Average error variance	F value	MSD (19:1)
I	10[a]	92.26	95.12	94.60	95.30	95.34	95.56	6.770	15.16	0.93
II	26[b]	72.28	87.54	87.96	89.07	89.68	90.83	21.230	294.46	1.43
III	12[c]	44.22	67.23	63.86	69.88	69.28	73.83	76.243	87.78	0.99
IV	3[d]	52.00	62.67	55.07	66.73	60.53	67.93	294.980	2.37	N.S.

[a] Test nos. 13A, 13B, 14A, 17A, 23A, 23B, 24D, 29A, 32A, 32B, 44B, 45A.

[b] Test nos. 10A, 14B, 17B, 19A, 20A, 20B, 24A, 24B, 24C, 29B, 30B, 30C, 30D, 35A, 35B, 36A, 36B, 38A, 38B, 40A, 41, 42B, 43A, 43B, 44A, 45B.

[c] Test nos. 2A, 4, 10B, 19B, 27 , 27B, 30A, 38C, 38D, 38E, 40B, 42A,

[d] Test nos. 2B, 7A, 7B.

Table 20. Summary of individual tests with Thomas Laxton peas on number of "strong plants," analyzed as randomized block tests (arranged according to the 3 groups of the combined analyses).

Test No.	Location	Average number of "strong plants" from seed treated with: Check	Red Cuprocide 0.251%	Arasan 0.167%	Arasan 0.223%	Spergon 0.167%	Spergon 0.223%	F Value	MSD (19:1)
14A	Md.	89.6	92.6	94.0	94.2	92.8	92.8	1.47	N.S.
17A	Mass.	90.4	92.8	95.2	95.0	94.6	96.6	4.23	3.14
20A	Minn.	69.2	90.2	87.2	88.0	91.6	90.4	21.58	5.36
23A	N. J.	87.6	91.6	87.2	88.2	89.2	88.0	1.13	N.S.
23B	N. J.	90.6	91.2	90.8	94.0	93.4	93.4	1.96	N.S.
24D	N. Y.	89.0	91.0	85.4	90.2	86.6	88.8	1.76	N.S.
30D	Okla.	37.2	85.0	82.8	89.0	87.2	88.0	138.17	5.07
35B	S. C.	80.2	81.8	89.0	85.4	86.8	91.8	5.67	5.39
36A	S. D.	74.2	81.8	79.8	80.0	82.6	78.0	2.54	N.S.
38A	Va.	30.0	79.0	85.2	92.0	87.6	89.8	152.80	5.40
44B	Wyo.	94.8	92.8	95.0	95.2	94.0	96.2	0.52	N.S.
45A	Canada	91.8	91.2	95.2	93.6	92.8	93.4	0.54	N.S.
10B	Idaho	49.4	50.6	53.4	48.8	51.2	55.4	0.04	N.S.
14B	Md.	47.8	85.6	79.4	85.2	87.6	91.4	44.45	7.08
17B	Mass.	81.4	85.2	82.8	73.0	84.2	75.6	3.12	8.24
20B	Minn.	65.2	84.2	77.8	76.0	80.8	84.2	5.37	9.05
24A	N. Y.	70.4	79.0	77.8	87.0	77.0	83.2	3.66	8.79
24B	N. Y.	42.2	67.4	69.0	73.2	63.8	69.8	18.70	7.69
24C	N. Y.	83.0	84.8	88.2	88.8	86.6	89.4	0.80	N.S.
27A	N. C.	7.4	27.2	10.4	14.4	14.8	16.8	5.26	6.45
30B	Okla.	78.4	91.8	90.0	91.4	88.6	89.0	5.06	6.51
30C	Okla.	72.0	89.0	89.6	89.2	90.8	92.8	13.01	6.21
35A	S. C.	67.6	76.0	80.4	87.0	88.6	89.6	13.10	7.03
36B	S. D.	47.8	81.8	67.8	75.4	77.4	82.8	28.73	7.19
38B	Va.	71.6	91.6	90.8	91.0	93.8	95.0	12.70	7.00
38C	Va.	75.4	80.8	82.4	89.0	88.4	82.4	1.60	N.S.
38E	Va.	6.8	57.4	42.8	55.8	57.4	71.0	35.30	11.00
41	W. Va.	74.4	77.6	85.4	84.2	84.8	83.0	2.89	7.78
42A	Wis.	76.8	67.6	80.6	77.6	72.0	74.4	1.95	N.S.
42B	Wis.	62.2	71.4	66.8	72.8	71.2	74.0	3.14	2.34
44A	Wyo.	85.0	88.8	88.0	89.4	90.2	93.2	0.84	N.S.
45B	Canada	76.4	73.0	87.8	82.6	88.0	89.6	6.55	12.30
27B	N. C.	8.8	43.2	30.8	31.8	46.8	56.0	3.72	25.16
30A	Okla.	3.0	56.6	39.8	59.6	41.0	56.2	13.14	17.26
38D	Va.	68.8	76.4	82.0	80.8	80.0	84.2	0.70	N.S.
43A	Wis.	24.8	59.2	69.6	77.6	62.0	76.4	7.14	21.48
43B	Wis.	20.8	66.8	68.8	72.0	62.6	70.2	6.90	2.17

Table 21. Summary of group analyses of "strong plants" tests with Thomas Laxton pea - 1944.

Group	No. tests	Average number of "strong plants" from seed treated with						Average error variance	F value	MSD (19:1)
		Check	Red Cuprocide	Arasan		Spergon				
			.251%	.167%	.223%	.167%	.223%			
I	12[a]	77.05	83.42	88.90	90.40	89.93	90.60	13.27	122.90	1.30
II	20[b]	62.06	75.54	74.56	76.59	76.86	79.13	42.92	86.84	5.74
III	5[c]	25.24	60.44	58.20	64.36	58.48	68.60	225.84	26.69	8.33

[a] Test nos. 14A, 17A, 20A, 23A, 23B, 24C, 30C, 35B, 36A, 38A, 44B, 45A.

[b] Test nos. 10B, 14B, 17B, 20B, 24A, 24B, 24C, 27A, 30B, 30C, 35A, 36B, 38B, 38C, 38E, 41, 42A, 42B, 44A, 45B.

[c] Test nos. 27B, 30A, 38D, 43A, 43B.

Table 22. Relative scores for pea seed treatment, represented as the percentage of the maximum number of times any one treatment could be better than all other treatments.

Treatment	Total emergence					"Strong plants"				
	Individual analyses		Group analyses			Individual analyses		Group analyses		
	Number[a]	Score (%)	Number[b]	Score (%)	Average score	Number[c]	Score (%)	Number[d]	Score (%)	Average score
Check	1	0.6	0	0.0	0.3	1	0.8	0	0.0	0.4
Red Cuprocide (0.251%)	35	21.9	4	26.7	24.3	27	22.5	3	20.0	21.3
Arasan (0.167%)	31	19.4	3	20.0	19.7	25	20.8	3	20.0	20.4
Arasan (0.223%)	41	25.6	6	40.0	32.8	33	27.5	5	33.3	30.4
Spergon (0.167%)	45	28.1	7	46.7	37.4	31	25.8	4	26.7	26.3
Spergon (0.223%)	59	36.9	11	73.3	55.1	44	36.7	7	46.7	41.7

[a] Maximum equals 160.
[b] Maximum equals 15.
[c] Maximum equals 120.
[d] Maximum equals 15.

all treatments are better than Arasan at 0.167%; Arasan at 0.223% and Spergon at both 0.167% and 0.223% are better than Red Cuprocide; and Spergon at 0.223% is also better than Spergon at 0.167% and Arasan at 0.223%.

The relative values of the various treatments are best summarized by the number of times that they are reported significantly better than some other treatment or the check. Such data converted to a score representing the percentage of the maximum number of times any one treatment could be better than all other treatments is given in Table 22. The scores obtained from both analyses are of the same order and indicate Spergon at 0.223% to be superior, followed in order by Spergon at 0.167%, Arasan at 0.223%, Red Cuprocide, and Arasan at 0.167%. The superiority of Spergon at 0.223% is further demonstrated by the fact that it was scored upon by some other treatment only 3 times out of a possible 160 in the individual tests and none in the combined analyses.

The possible protective value of seed treatment against fertilizer injury is demonstrated in tests numbers 38A and 38B, conducted in Virginia. Both tests were planted simultaneously in the same soil. The seeds in test No. 38A were planted in rows in which fertilizer had been previously mixed with the soil; those in test No. 38B in rows in which no fertilizer was applied. The emergence data show a much lower stand in the fertilized checks than in the unfertilized; whereas, the stand among the various treatments is practically identical regardless of fertilizer application.

"Strong Plants"

Similar trends with respect to the effect of treatment were obtained on numbers of "strong plants." Significant differences in number of "strong plants" occurred in 24 (65 percent) of the 37 individual tests listed in Table 20.

The combined tests were analyzed in the 3 groups listed in Table 21. All treatments are significantly better than the check in all 3 groups. In Group I, Arasan (0.223%) and Spergon (0.167%) and (0.223%) are better than Red Cuprocide; Arasan and Spergon at 0.223% are better than Arasan at 0.167%. In Group II, no differences occurred among treatments. In Group III, Spergon at 0.223% is better than either Arasan or Spergon at 0.167%.

The relative values of the various treatments with respect to "strong plants" are given in Table 22. In general, they show the same trend as in total emergence, except that Arasan at 0.223% has a higher score than Spergon at 0.167%.

Summary

The 1944 data indicate that all materials are beneficial to the emergence of peas. Significant improvement in emergence was obtained in 61 percent of the individual tests. When all individual tests were analyzed in the combined tests, significant increases in emergence were obtained in groups which represented 94 percent of the total individual tests. Similar trends were obtained with the "strong plant" data. As in previous years, Spergon gave the best results. Spergon at 2 ounces per bushel, however, was better than the lower rate of 1 1/2 ounces per bushel. Arasan at 2 ounces per bushel and Spergon at 1 1/2 ounces per bushel appeared to be equally effective. Arasan at 1 1/2 ounces per bushel and Red Cuprocide at 2 1/4 ounces per bushel were inferior, but better than the untreated seed. Both Arasan and Red Cuprocide require graphite to insure a seeding rate equal to that of untreated seed.

NEW YORK STATE AGRICULTURAL EXPERIMENT STATION, GENEVA

VIII. VEGETABLE SOYBEAN SEED TREATMENTS

R. H. Porter

Seed treatment trials with vegetable soybean seed were conducted by 18 cooperating stations in 1944 but reports from one were not received in time to be included in the statistical analysis and summary.

Of the 17 reports only 5 gave results in which significant differences occurred between percentages of germination from treated and untreated seed. The variety used was Banzei and the seed was of high quality with a germination of 98 percent in the sand test conducted by the Iowa State College Seed Laboratory.

The treatments were Arasan, Spergon, and Fermate each at the rates of .156 and .208 percent, which are equivalent to 1 1/2 and 2 ounces per bushels respectively.

All plots were planted in randomized blocks of 5 replications, each replication consisting of 7 rows, 2 feet apart, rows 8 feet long and 100 seeds per row. The ranges (replications) were end to end. Each cooperator was given a different randomization of numbers.

The data obtained from emergence counts made by each cooperator are given in Tables 23 and 24. Table 23 includes the 5 plots in which significant differences between the untreated and one or more treated lots were obtained. The data from the other 12 plots are shown in Table 24.

In addition to the analysis by plot, two over-all analyses were made, one with the data from the 5 locations given in Table 23 and a second with the data from all 17 locations. The results of these analyses are as follows:

1. Analysis by plot (Table 23).

Significant increases in emergence from the treated lots above the untreated occurred once in Florida, 3 times in New Jersey, 4 times in New York, 6 times in South Carolina and once in Virginia. In no case was any treatment significantly lower than the untreated, but there are several instances where a treatment was significantly different from others.

2. Over-all analysis of data in 5 plots (Table 23).

Taking the data as a whole in the 5 plots in which significant differences occurred the analysis gave 4.85 as the least difference for significance between the means at the 5 percent point, which indicates that the mean of the percentage emergence for each of the 6 treatments

Table 23 - Percent emergence of treated and untreated Banzei soybean seed in five locations.

Test no.	Cooperating Station	Check	Arasan 1 1/2 oz.	Arasan 2 oz.	Spergon 1 1/2 oz.	Spergon 2 oz.	Fermate 1 1/2 oz.	Fermate 2 oz.	LDS#
6	Fla.	91.4	94.0	95.8	97.0	94.6	91	88.2	5.57
23	N. J.	90.8	95.0	90.0	93.4	94.2	95.6	88.0	2.99
25	N. Y. (L.I.)	91.6	96.6	94.2	97.6	94.0	96.4	96.0	3.00
35	S. C.	39.8	53.0	62.6	53.6	58.2	64.2	65.6	8.15
38A	Va. (Hampton)	88.4	88.0	91.4	91.8	95.2	91.2	91.6	3.76
	Mean %	80.4	85.3	86.8	86.7	87.4	87.2	85.9	4.85

#LDS - Least difference for significance between treatments at 5% point.

Table 24 - Percent emergence of treated and untreated Banzei soybean seed in 12 locations in each of which no significant differences between treatments occurred.

Test no.	Cooperating Station	Check	Arasan 1 1/2 oz.	Arasan 2 oz.	Spergon 1 1/2 oz.	Spergon 2 oz.	Fermate 1 1/2 oz.	Fermate 2 oz.
13	Iowa	93.2	94.2	92.2	94.8	94.8	93.4	95.6
17	Mass.(Waltham)	91.6	94.4	90.8	89.8	95.2	90.6	91.0
27	N. C.	87.4	84.2	90.0	87.8	87.0	84.8	90.4
28	N. Dak.	93.2	92.8	94.4	94.2	92.4	92.6	95.8
29	Ohio	76.8	78.6	85.8	86.8	83.6	76.8	80.2
30	Okla.	88.0	94.0	91.8	92.4	94.2	92.6	93.0
32	Pa. (College)	97.0	96.8	97.0	97.0	97.0	96.6	97.6
33	Pa. (Burpee)	90.0	91.0	92.2	93.4	95.4	93.4	93.2
34	S. C.	91.4	91.2	91.2	94.6	94.6	89.6	94.2
38B	Va.(Diamond Sp)	82.6	84.6	87.0	81.2	89.2	89.2	90.0
39	Wash.	93.6	95.0	91.8	94.4	94.8	89.6	86.0
41	W. Va.	93.2	94.6	92.4	96.4	92.0	94.4	96.0
	Mean % emergence for all 17 plots	87.0	89.3	90.0	90.4	93.3	89.5	90.2

was significantly higher than that of the untreated. It must be recognized that such an analysis is based on selected data, which procedure may be questionable in that the probability may be higher. The only reason for this grouping is that the results in the other 12 plots were either extremely variable or the differences were uniformly small. In the latter case it must be assumed that the conditions for seed germination were equally favorable for the treated and untreated samples.

3. Over-all analysis of the data in 17 plots.

When the analysis was made of all the data grouped together it was found that there were significant differences between individual percentages as between locations, the least difference for significance being 10.32 at the 5 percent point. An examination of the data indicates that any significant differences are largely the result of location rather than treatment and only in the South Carolina plot are the differences between individual treatments equal to or greater than 10.32. The means of all treatments in the 17 plots are so close together that the only treatment which might possibly be considered superior to the others is Spergon (2 oz.).

The conclusion that may be drawn from the tests in 1944 using seed of Banzei soybean with an exceptionally high vitality is that seed protection was of some value in about 1/3 of the locations and not all compounds were equally effective in each of those locations. All the plots in which significant differences occurred were in states along the Atlantic seaboard. In 3 of those the soil was optimum as to moisture and in 2 it was wet at planting time. Spergon at the rate of 2 ounces per bushel gave the most consistent increases in emergence over the untreated not only in the 5 selected plots but in all the 17 plots. Given unfavorable conditions for germination in the field, one could expect seed protectants to be of value even with seed of high vitality and if seed of low vitality were used the benefit should be greater. The tests in 1945, if continued, should include a lot with less vitality than that of the 1944 lot.

IOWA STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS, AMES, IOWA

IX. SPINACH SEED TREATMENTS

G. K. Parris

During 1944, the following chemical seed treatments were tried on spinach: - Arasan (0.25% and 0.50% by weight), Fermate (0.50% and 0.75%), and Zinc oxide (1.5% and 2.0%). Thirty-six sets of data from 29 cooperators located in 25 States of the United States and one Canadian Province were submitted for analysis. Nineteen cooperators reported significant differences between treatments.

The data given in Table 25 indicate the geographical location and key number of each cooperator, and the prevailing environmental conditions for each test. In Table 26 are given the 36 tests, arranged in order of their respective error variances, and the mean percent seedlings emerged per treatment. To these data have been applied an analysis designed by Roessler and Leach (footnote, page 6), which applies the Chi-square test to determine the homogeneity of data from different locations. Eighteen tests (numbers 27, 28, 29A, 38A, 8A, 29B, 35, 17, 45, 38B, 2, 20, 44, 24, 30A, 10, 38C, and 8B) with low error variances fall into homogeneous Group 1, and 15 other tests (30C, 5, 36, 1, 4, 31, 30B, 33, 23, 42, 19, 34, 43, 3, and 32) constitute a second homogeneous group (Group 2). Two tests, both with very low error variance (25 and 41) do not fit into either Group 1 or Group 2 and must be considered alone (Group 3). Outstanding is test no. 14 which has an error variance so large that it cannot be fitted into any one of the three groups.

Emergence

The least difference necessary for significance between the means of Group 1 is 1.7 seedlings (Table 27). Thus all treatments are better than the control, and zinc oxide is the best treatment. Between Arasan and Fermate there is no significant difference. Zinc at 1.5% is just as good as zinc at 2% and the same is true of different rates of Arasan and Fermate.

In Group 2, the least difference necessary for significance is 2.8 seedlings. Again all treatments are better than the check, and again zinc is the superior of Arasan and of Fermate. There was no difference between rates of application for zinc, Arasan, or Fermate.

In Group 3 the same general trends hold.

Post-emergence Damping-off

Thirteen cooperators reported post-emergence data. When analysed, 9 tests showed no significant difference between treatments. In one of

TABLE 25. Location, time, and environmental conditions of spinach seed treatment tests - 1944.

Report from: Test no.	Report from: Locale	Planting date 1944	Planted in	Soil conditions: pH	Soil conditions: Moisture	Rainfall inches	Average temperature °F. Min.	Average temperature °F. Max.	Soil type
1	Ark.	4/5	Field	-	Optimum	4.00	45	70	Clarksville silt loam
2	Calif.	2/18	Field	6.8	Dry	2.64	37	62	Fine sandy loam
3	Conn.	5/20	G.B.*	6.2	Very wet	2.00	63	87	Sandy loam
4	Del.	4/30	Field	-	Wet	0.57	49	78	Sassafras silt loam
5	Fla.	2/18	Field	5.8	Optimum	Irrig.	53	79	Loamy sand
8A	Ga.	3/8	G.B.*	5.6	Optimum	Irrig.	50	88	Sandy loam
8B	Ga.	3/10	Field	5.7	Dry	4.70	41	69	Cecil clay
10	Idaho	4/7	Field	6.9	Dry	2.66	50	35	Palouse silt loam
14	Md.	9/21	Field	5.4	Optimum	2.05	49	67	Sandy loam
17	Mass.	4/20	Field	6.0	Optimum	2.16	37	64	Merrimac Gravelly sandy loam
19	Mich.	4/29	Field	7.2	Optimum	1.16	43	-	Sandy loam
20	Minn.	5/15	Field	5.2	Optimum	0.98	55	72	
23	N. J.	4/14	Field	5.8	Optimum	4.01	38	58	Sassafras loam
24	N. Y.	5/2	Field	7.0	Optimum	2.90	49	76	Dunkirk silty clay loam
25	N. Y.	5/10	Field	6.1	Optimum	0.67	56	74	Black sandy loam
27	N. C.	4/7	Field	5.6	Wet	5.17	51	74	Norfolk sandy loam
28	N. Dak.	4/13	Field	7.0	Optimum	1.06	34	56	Fargo clay
29A	Ohio	4/26	Field	5.8	Optimum	-	-	-	Muck
29B	Ohio	4/26	Field	6.2	Wet	-	-	-	Loam
30A	Okla.	3/7	G.B.	7.1	Wet	Irrig.	65	71	Sandy clay loam
30B	Okla.	3/9	Field	6.1	Dry	1.88	38	61	Loam
30C	Okla.	3/24	Field	5.1	Optimum	0.38	38	63	Fine sandy loam
31	Oreg.	3/15	Field	6.0	Dry	0.77	36	59	Chehalis clay loam
32	Pa.	5/15	Field	7.5	Optimum	3.21	56	78	Hagerstown clay loam

33	Pa.	9/27	Field	-	Optimum	-	-	-	
34	S. C.	3/2	Field	5.1	Optimum	5.01	41	66	Sandy loam
35	S. C.	3/27	Field	5.7	Wet	1.48	43	62	Portsmouth sandy loam
36	S. Dak.	5/22	Field	6.5	Wet	0.03	53	81	Barnes loam
38A	Va.	2/23	G.B.*	5.8	Optimum	Irrig.	61	85	Sandy loam
38B	Va.	4/11	Field	6.2	Optimum	2.37	50	72	Sandy loam
38C	Va.	4/21	Field	6.2	Optimum	0.80	53	77	Sandy loam
41	W. Va.	2/21	G.B.*	-	Optimum	Irrig.	-	-	Loam
42	Wis.	5/24	Field	6.2	Optimum	-	-	-	Loam
43	Wis.	5/2	Field	6.4	Optimum	1.63	53	70	Miami silt loam
44	Wyo.	5/6	Field	7.5	Dry	0.65	38	64	Sandy loam
45	Canada	4/5	G.B.*	7.4	Optimum	Irrig.	55	89	Loam

* Greenhouse bench or flat.

TABLE 26. Summary of spinach tests analysed separately as randomized block experiments.

Cooperator no.	Locale	Mean percent seedlings emerged: Arasan 0.25%	Arasan 0.50%	Formate 0.50%	Formate 0.75%	Zinc oxide 1.5%	Zinc oxide 2.0%	Check	Error variance	Log Vi
25	N. Y.*	48.4	51.2	41.6	45.0	63.2	56.4	39.2	11.7	1.0682
41	W. Va.*	64.4	73.2	67.0	67.2	71.8	69.4	51.4	14.3	1.1523
27	N. C.*	10.0	12.2	15.2	4.2	11.6	8.6	3.8	22.0	1.3424
28	N. Dak.	42.0	40.6	39.4	52.5	37.6	36.6	40.2	22.2	1.3464
29A	Ohio*	57.0	65.0	60.0	54.0	63.0	59.0	43.0	24.7	1.3927
38A	Va.*	61.3	56.0	68.0	62.0	54.3	58.0	12.0	24.8	1.3945
8A	Ga.*	73.0	75.0	72.8	75.0	76.2	78.2	64.4	25.3	1.4031
29B	Ohio	10.4	15.4	10.0	15.6	20.4	17.4	15.8	25.3	1.4031
35	S. C.*	70.6	72.2	69.2	73.8	65.2	68.4	54.4	27.6	1.4409
17	Mass.*	72.6	67.8	60.6	73.4	76.2	72.8	38.4	32.2	1.5079
45	Canada*	82.0	80.6	79.2	85.6	81.8	82.4	65.0	33.9	1.5302
38B	Va.	10.6	9.0	9.3	8.6	15.0	12.6	8.6	35.4	1.5490
2	Calif.*	51.0	48.8	50.0	50.2	63.8	55.2	54.2	36.5	1.5623
20	Minn.	34.8	42.0	37.6	37.4	43.8	34.7	32.6	40.1	1.6031
44	Wyo.	48.6	47.2	41.8	50.4	46.6	50.4	47.4	42.9	1.6325
24	N. Y.	62.2	56.6	60.0	61.8	63.4	62.2	60.2	43.8	1.6415
30A	Okla.*	65.4	69.4	68.8	71.0	72.4	64.4	52.6	51.5	1.7118
10	Idaho	76.0	75.2	66.0	71.4	70.8	70.8	67.8	54.5	1.7364
38C	Va.	41.8	39.8	45.2	37.8	50.6	49.8	48.0	59.9	1.7774
3B	Ga.	57.2	49.6	52.2	50.4	58.8	62.0	50.4	64.9	1.8122
30C	Okla.	57.6	59.8	43.0	52.0	60.6	58.8	28.4	66.6	1.8235
5	Fla.	44.6	39.8	40.0	40.0	48.2	50.8	49.0	70.2	1.8463
36	S. D.*	36.2	29.2	38.2	35.4	47.2	40.0	29.0	71.1	1.8519
1	Ark.	57.8	55.6	60.0	61.8	62.0	63.8	48.4	75.0	1.8751
4	Del.*	41.2	59.0	43.8	42.6	58.2	53.6	50.0	81.0	1.9095
31	Oreg.	55.8	57.4	52.2	53.6	69.0	64.4	62.2	86.1	1.9350

30B	: Okla.	: 62.0	59.6	61.4	68.8	66.6	69.2	57.2	: 87.9	: 1.9440
33	: Pa.	: 48.6	53.4	43.4	52.4	47.2	41.0	22.2	: 96.7	: 1.9854
23	: N. J.*	: 47.4	62.6	60.0	55.8	56.2	54.0	40.2	: 96.3	: 1.9859
42	: Wis.	: 37.6	36.0	34.4	30.2	36.2	30.2	35.0	: 98.0	: 1.9912
19	: Mich.*	: 34.6	37.4	27.4	26.6	43.4	41.0	22.6	: 106.6	: 2.0278
34	: S. C.	: 37.8	32.0	28.8	28.8	39.2	42.4	35.8	: 109.9	: 2.0411
43	: Wis.*	: 39.6	34.8	33.8	36.6	32.4	41.4	7.2	: 123.6	: 2.0920
3	: Conn.	: 47.4	54.0	58.6	51.8	53.2	50.6	34.0	: 154.4	: 2.1886
32	: Pa.	: 32.2	32.6	34.8	26.0	30.8	40.8	33.8	: 187.3	: 2.2725
14	: Md.*	: 39.8	40.6	36.2	33.0	19.4	25.4	4.4	: 260.7	: 2.4161
Totals		-	-	-	-	-	-	-	2465.4	62.1938

* Significant difference between treatments.

TABLE 27. Effect of chemical seed treatments on emergence of spinach seedlings.

Group	Number locations	Average Number of Seedlings: Arasan 0.25%	Arasan 0.50%	Fermate 0.50%	Fermate 0.75%	Zinc oxide 1.5%	Zinc oxide 2.0%	Check	Average error variance	Least difference required for significance
1	18	51.4	51.2	50.2	51.9	54.0	52.4	42.1	37.0	1.7
2	16	42.5	43.9	41.2	41.4	46.9	46.3	34.6	82.7	2.8
3	2	56.4	62.2	54.3	56.1	67.5	62.9	45.3	13.0	3.2
Test 14	1	39.8	40.6	36.2	33.0	19.4	25.4	4.4	260.7	21.0

the 4 tests where a significant difference was found, more seedlings damped-off where treated seed was planted than in the checks, leaving only 3 treatments worthy of consideration. In all 3 tests, zinc oxide and Arasan reduced post-emergence damping-off significantly; there seemed to be no difference between rates of application. In 2 out of the 3 tests, Fermate reduced damping-off, also without difference between rates of chemical applied.

Summary

As recognized previously, and repeated in 1944, seed treatment of spinach is worthwhile. Arasan, Fermate, and zinc oxide, at all rates tried, gave significant increases over untreated checks. However, in 1944 the best treatment was zinc oxide, either at 1.5% or at 2%. Fermate (like zinc oxide) is abrasive to spinach seed, and in view of the 1943 and 1944 findings the use of this material, either commercially or in national cooperative seed treatment tests, is not to be encouraged. The failure of Arasan to measure up to zinc oxide, as found in 1943, is disappointing, for this material is not abrasive and seedsmen dislike the graphite they have to add as lubricant. Seed bags in which graphite-treated seed has been stored decay more rapidly than bags without graphite and are practically impossible to clean, and their resale value is much reduced.

Reduction in the rate of zinc oxide from 2.0% to 1.5% means a saving in cost of treatment from \$0.45 to \$0.60 per 100 pounds of seed to \$0.34 to \$0.45. It may be of interest to report that seedsmen in the Tidewater area of Virginia have actually been using zinc oxide at the 1.5% rate for years.

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X. SWEET CORN SEED TREATMENTS

B. H. Davis

A lot of sweet corn seed of the variety Ioana with a low germination test (73%) was purposely selected for the 1944 cooperative tests. Although the data from such a low vitality lot favor the use of seed protectants, it was hoped that the potentialities of the various protectants would be brought out more strongly than in the past when seed lots with high germination tests were used.

Two dosages (1.5 and 3.0 oz. per bu.) of 4 protectants, Semesan Jr., Arasan, Spergon, and Barbak C, were planted along with the nontreated in 5 replications of 100 seed each. From 32 lots of seed planted by 24 cooperators in 15 States and one Canadian Province, data were received from 30. Records of the environmental conditions prevailing at each of these locations are given in Table 28 and the mean seedling counts and the statistical significance of the data are presented in Table 29.

It is highly significant that of the 30 tests conducted 27 or 90% showed a significantly higher emergence from the treated than from the nontreated seed. This is a much higher percentage than that obtained in previous years when seed lots with high germination tests were used.

The number of tests in which seedling emergence for one treatment was significantly greater than that for each other treatment and the relative value of the several treatments follows: (Maximum score 216)

Column 1	Number of times treatment in Column 1 was better than: Semesan Jr. 1.5	Semesan Jr. 3.0	Arasan 1.5	Arasan 3.0	Spergon 1.5	Spergon 3.0	Barbak C 1.5	Barbak C 3.0	Check	Score of treatments
Semesan Jr. 1.5		1					5	2	7	15
Semesan Jr. 3.0	5		1		2	1	7	5	11	32
Arasan 1.5	21	22		1	13	11	23	22	25	138
Arasan 3.0	22	21	2		16	8	26	24	26	145
Spergon 1.5	11	6					18	15	21	71
Spergon 3.0	18	17			5		22	21	25	108
Barbak C 1.5	1								2	3
Barbak C 3.0	1	1					3		8	13
Check							1			1

An analysis of combined data produces a homogeneous group (footnote, page 6) if tests 34, 4 and 38A are omitted. The averages and statistical analysis for the 27 tests follows:

No. of tests	Average Number of Seedlings									Average error variance	F value	L.D.S*
	Semesan Jr.		Arasan		Spergon		Barbak C		Check			
	1.5	3.0	1.5	3.0	1.5	3.0	1.5	3.0				
27	45.9	47.4	59.7	61.4	51.2	55.3	42.0	44.2	39.9	33.28	26.8	1.4

* Least difference required for significance at 5% level.

In these 1944 tests seed treated with each of the four protectants at the dosages indicated produced a significantly greater number of seedlings than the untreated seed. Arasan was the outstanding protectant, followed by Spergon, Semesan Jr., and Barbak C, with each material significantly better than each following material. Also, in the case of each protectant the 3 oz. dosage was significantly better than the 1.5 oz. dosage.

Data on "very weak seedlings" were obtained from 19 of the 30 tests. These data were not treated statistically but the mean emergence and the percentage of the seedlings classified as "very weak" were calculated for the check and for each of the 4 protectants (both dosages combined) for the 19 tests taken as a group. These data are presented below:

Protectant	Mean emergence	Percent Weak Seedlings
Arasan	61.0	7.14
Spergon	53.7	9.61
Semesan Jr.	46.8	11.16
Barbak C	43.3	12.52
Check	39.9	12.69

It will be seen that the lowest percentage of weak seedlings and the highest mean emergence were obtained from seed treated with Arasan and that without exception the higher the mean emergence for the treatment the lower the percentage of weak seedlings. Thus the seed protectant may benefit not only by increasing the total emergence but also by decreasing the percentage of weaklings in the final stand. This same relationship held for the results obtained in 1943 when it was stated that the data "would indicate definitely that a greater benefit may be derived from treatments than are shown in the 'total emergence' used in calculations."

Table 28. Location, time and environmental conditions for Cooperative Sweet Corn Tests - 1944

Coop. No.	Locality	Planting date	Planted in*	Soil: pH	Soil: Moisture at planting	Soil: Type	Germ. Period b: Total precipitation	Germ. Period b: Mean air temperature Min. Max.	No. of days to emergence a
							In.	°F °F	
12	Ind.	4/21	F	-	Wet	Sandy	2.07	47-67	-
14	Md.	2/12	G.B.	5.6	Wet	Sandy loam	*	49-77	11
38B	Va.	4/11	F	5.7	Optimum	Sandy loam	2.37	49-74	16
30A	Okla.	4/22	F	5.14	Optimum	Sandy loam	3.01	54-72	11
13	Ia.	4/17	F	Neutral	Very wet	- - -	-	-	-
30C	Okla.	4/25	F	5.14	Optimum	Sandy loam	1.72	49-73	11
17	Mass.	5/4	F	6.25	Optimum	Sandy loam	.33	44-75	11
5	Fla.	2/18	F	5.7	Optimum	Sandy loam	.03	58-84	6-8
38C	Va.	4/21	F	6.2	Optimum	Sandy loam	.53	53-78	15
22A	Nebr.	5/16	F	7.4	Optimum	Clay loam	.71	64-85	-
44A	Wyo.	5/6	F	7.5	Optimum	Sandy silt loam	.75	38-64	26-28
25	N. Y.	5/9	F	6.24	Optimum	Sandy loam	.57	56-72	14
32	Pa.	6/1	F	6.7	Optimum	Clay loam	2.53	55-75	-
3	Conn.	5/18	F	6.2	Optimum	Sandy loam	-	48-74	11
33	Pa.	6/22	F	-	Wet	- - - -	-	-	-
20	Minn.	5/15	F	5.6	Optimum	Silt loam	1.40	56-74	11
44B	Wyo.	5/23	F	7.5	Optimum	Sandy silt loam	1.69	41-63	20
30B	Okla.	4/8	F	6.17	Optimum	Loam	3.65	50-76	14
34	S. C.	3/15	F	5.2	Optimum	Sandy loam	5.54	48-71	10
4	Del.	4/30	F	-	Opt. to wet	Silt loam	.57	50-78	-

40	Wash.	5/17	F	7.2	Very dry	Palouse loam	.08	42-62	-
22B	Nebr.	5/18	F	7.1	Optimum	Clay loam	2.53	62-85	-
35	S. C.	4/17	F	5.72	Optimum	Sandy loam	3.58	60-77	6-7
24	N. Y.	5/26	F	7.8	Optimum	Ontario loam	.81	58-84	10
29	Ohio	5/9	F	6.2	Wet	Silt loam	3.11	-	-
23	N. J.	5/5	F	5.2	Optimum	Sassafras loam	2.00	53-72	10
36	S. Dak.	5/23	-	6.5	Wet	Barnes loam	.26	55-82	-
22C	Nebr.	5/19	F	6.8	Optimum	Clay loam	1.13	64-82	-
38A	Va.	5/26	F	5.8	Dry	Sandy loam	*	65-86	8
45	Canada	5/23	F	5.18	Very dry	Sandy	1.15	52-78	8-11

NOTES:- * F-field; G.B. - greenhouse bench.

** Artificially watered.

a "Number of days to emerge" was taken as the time between planting and time when the majority of the seedlings emerged.

b When sufficient data were supplied the germination period was arbitrarily considered as 50% longer than "number of days to emerge" in order to include data on moisture and temperatures during the period of post-emergence damping-off. In some cases the environmental data were supplied only to the time when the majority of seedlings emerged.

Table 29. Effect of seed protectants on emergence of sweet corn seedlings.

Coop. No.	Locality	Semesan Jr. 1.5	Semesan Jr. 3.0	Arasan 1.5	Arasan 3.0	Spergon 1.5	Spergon 3.0	Barbak C 1.5	Barbak C 3.0	Check	Diff. req. sign.*	Calc. "F" Value
		Seedling emergence, percent from 500 seeds										
12	Ind.	15.6	15.4	48.2	65.4	32.8	36.0	13.8	13.4	8.8	8.66	39.89
14	Md.	32.2	38.4	58.0	64.2	40.8	45.2	24.2	28.2	21.0	6.84	38.01
38B	Va.	14.0	21.2	48.6	52.0	28.[illegible]	38.8	14.4	16.2	17.8	7.36	34.50
13	Ia.	9.2	16.8	34.6	42.8	23.0	31.8	6.8	8.4	5.2	7.31	29.93
30A	Okla.	36.6	32.4	60.6	65.0	42.4	51.4	31.8	41.0	30.6	7.40	24.75
30C	Okla.	37.8	33.6	57.0	60.0	47.0	48.6	33.8	39.8	30.6	6.47	22.35
17	Mass.	57.6	55.4	70.4	73.4	63.4	69.0	46.2	47.4	43.2	11.64	21.83
5	Fla.	51.4	60.8	69.0	69.6	60.2	57.8	38.6	48.4	46.0	7.07	18.31
38C	Va.	41.6	42.8	66.2	66.6	50.4	59.4	41.6	38.4	37.0	8.28	16.99
22A	Nebr.	56.6	65.2	70.4	64.8	54.8	60.0	43.6	47.2	48.4	6.33	16.96
44A	Wyo.	46.8	45.8	62.6	59.2	47.2	54.4	42.0	40.2	38.4	6.67	13.40
25	N. Y.	53.2	56.6	69.8	69.2	62.8	63.4	46.2	51.3	43.4	7.00	13.01
32	Pa.	58.0	50.6	60.2	61.2	55.0	57.6	55.2	50.2	40.0	5.82	10.56
3	Conn.	47.6	43.6	63.8	65.6	53.4	60.4	47.6	46.0	44.2	7.82	10.22
33	Pa.	53.6	50.0	61.8	61.0	50.6	55.8	44.4	46.0	36.6	8.35	7.59
20	Minn.	35.2	36.8	48.8	53.8	40.2	45.2	29.6	30.6	30.6	9.46	7.04
44B	Wyo.	48.8	53.6	65.0	59.8	57.2	59.0	50.4	47.4	37.6	9.51	6.25
30B	Okla.	53.0	53.8	64.0	64.4	57.8	62.8	47.8	47.0	43.2	8.25	6.18
34	S. C.	50.2	48.8	63.2	66.6	64.2	65.2	52.4	54.8	42.6	10.90	5.21
4	Del.	49.6	42.4	61.8	60.0	50.6	57.0	39.0	39.8	38.6	12.01	4.97

4C	Wash.	49.0	41.4	55.0	57.6	51.8	51.2	43.3	46.8	40.2	7.99	4.69
22B	Nebr.	36.8	57.0	46.8	55.0	46.2	47.2	46.8	46.2	40.8	8.29	4.66
35	S. C.	60.2	60.4	63.4	67.8	62.0	66.6	56.2	60.0	57.4	5.36	4.34
24	N. Y.	49.2	[illegible]	55.0	54.8	52.6	54.8	46.2	46.2	45.6	5.64	4.16
29	Ohio	56.0	64.6	64.4	62.6	61.6	61.0	52.4	62.0	53.4	6.91	3.75
23	N. J.	61.0	57.3	66.2	60.6	61.8	59.6	56.4	60.0	57.0	5.37	2.53
36	S. Dak.	49.0	53.0	55.0	60.2	56.4	59.2	52.0	55.6	49.8	7.35	2.32
22C	Nebr.	61.0	54.8	60.2	51.8	58.8	65.2	55.8	58.4	54.4	N.S.	2.19
38A	Va.	64.2	62.6	62.0	68.0	60.2	62.0	59.4	56.4	57.6	N.S.	.98
45	Canada	67.8	69.2	67.2	68.4	64.0	70.4	66.8	65.2	61.0	N.S.	.87

* Mean difference required at 5% level.

Data on the mean height of plants supplied by one cooperator (Brooks, Florida) taken 34 days after planting, show that both dosages of Arasan are significantly better than all remaining treatments except Semesan Jr. at 1.5 oz. The poorest results were obtained with Barbak C. The order of the three best treatments was Arasan 3 oz., Arasan 1.5 oz., and Spergon 3 oz., which is the same order as that based on increased total emergence. The order, on the same basis, for the remaining treatments is altered somewhat, particularly with respect to dosages. However, the order for materials is again the same, namely; Arasan, Spergon, Semesan Jr., and Barbak C.

Data on uniformity of emergence were supplied from one test (No. 14, Cox, Maryland). Two counts were made, one 14 and a second 28 days after planting. The percentage of the final mean stand that had emerged at the time of the first count ranged from 95.5 to 82.3. With only one test the data are too meager to draw definite conclusions but they suggest that those treatments which give the highest mean emergence and the lowest percentage of weak seedlings also encourage prompt and uniform emergence.

From the standpoint of increased emergence, decreased percentage of weak seedlings, increased plant growth (1 test) and uniformity of emergence based on 2 counts at 14 day periods (1 test), Arasan is the outstanding material in the 1944 cooperative sweet corn tests.

NEW JERSEY AGRICULTURAL EXPERIMENT STATION, NEW BRUNSWICK, NEW JERSEY.

XI. TOMATO SEED TREATMENTS

S. P. Doolittle and F. S. Beecher

The 1944 trials of seed protectants included most of the treatments used in the 1943 tests and were intended to supply further evidence as to the relative value of certain of the older standard treatments and some newer compounds now being rather widely used. The single new treatment in 1944 consisted of the use of New Improved Ceresan as a dust. This treatment, introduced by B. H. Davis and C. M. Haenseler of the New Jersey Experiment Station, presents a possible substitute for the 1-1200 New Improved Ceresan dip now generally applied to seed used for tomato plant production in the South.

All of the seed (Rutgers variety) was treated at Beltsville, Maryland, and sent to the cooperators, who planted it in 5 randomized blocks each consisting of 7 treatment plots of 100 seeds each. The data were taken on the basis of total emergence and were analyzed statistically by a standard method.

Through the kindness of Mrs. Vivian K. Toole of the Bureau of Plant Industry, Soils, and Agricultural Engineering, seed samples of each treatment and the check were tested for germination according to the rules of the Association of Official Seed Analysts. The testing was done during June, 1944, and there were no significant differences, the final figures ranging from 94.0 to 96.75 percent.

The treatments used were: Spergon (0.3% by weight of seed); Arasan (0.3%); Semesan (0.3%); Yellow Cuprocide (1.5%); New Improved Ceresan dust (0.5%); a 5-minute dip in a 1-1200 solution of New Improved Ceresan; and an untreated check.

In the tomato tests, data were received for 14 trials conducted in various localities in 11 States. Eight of these trials were made in the greenhouse and 6 in the field. Two of the latter trials were abandoned because of crusting of the soil, and no emergence counts were made.

Table 30 shows the location, time of planting, environmental conditions, and average number of days required for emergence of seedlings. The data on total emergence and their statistical significance are given in Table 31.

Table 32 shows the number of tests in which seedling emergence of any single treatment was significantly greater than that for any other treatment and indicates the relative value of the various treatments in this set of tests, when compared in such a manner.

Table 30. Location, time, and environmental conditions of tomato seed treatment tests with Rutgers variety in 1944.

Report from: Test no.	State	Planting date	Soil conditions: Type	pH	Moisture	Rainfall In.	Air temperature Min. °F	Max. °F	Days to emerge
3	Conn.	5/20	Sandy loam	6.2	Very wet	G.H.[a]	58	95	7
8	Ga.	4/1	Sandy loam	5.7	Optimum	G.H.	25	104	18
14	Md.	4/20	Sandy loam	5.6	Wet	G.H.	39	96	8
15	Md.	4/10	Sandy loam	5.7	Wet	G.H.	63	92	12
23	N. J.	3/16	Sandy loam	6.85	Wet	G.H.	44	84	7
25	N. Y.	5/12	Sandy loam	6.15	Optimum	-	46	84	12
33	Pa.	8/9	Sandy loam	-	Dry	-	-	-	-
35	S. C.	3/27	Sandy loam	5.72	Wet	1.48	28	78	10 - 12
38A	Va.	3/16	Loamy sand	7.2	Optimum	G.H.	49	103	9
38B	Va.	4/21	Sandy loam	6.2	Optimum	.81	41	89	11
40	Wash.	3/20	Loam and peat	5.8	Optimum	G.H.	60	80	8
41	W.Va.	3/23	Loam	5.3	Optimum	G.H.	55	88	7

[a] G.H. refers to greenhouse test.

Table 31. Emergence data for cooperative tomato seed tests analyzed as randomized block tests, 1944.

Report from:		Average emergence from seed treated with							Least	Calculated
Test no.	State	Spergon 0.3%	Arasan 0.3%	Semesan 0.3%	Yellow Cuprocide 1.5%	New Improved Ceresan 0.5%	New Improved Ceresan dip 1-1200	Untreated check	significant difference[a]	"F" Value
		%	%	%	%	%	%	%	%	
15	Md.[b]	94.6	93.2	95.8	95.6	92.2	93.6	85.4	4.33	5.69
23	N. J.	84.8	93.0	87.8	92.0	91.4	92.6	81.6	5.17	5.68
35	S. C.	74.4	83.2	82.6	76.4	79.6	74.4	69.0	6.69	4.89
40	Wash.	90.2	95.6	85.4	94.0	92.2	94.6	64.8	6.93	20.73
41	W. Va.	87.2	94.4	91.2	94.6	93.0	94.6	84.2	4.29	7.81
3	Conn.	56.8	55.8	62.4	60.2	65.4	53.6	56.8	NS	0.76
8	Ga.	86.8	87.6	89.2	88.2	90.6	90.8	87.6	NS	0.59
14	Md.	84.4	84.6	82.3	88.6	90.6	82.8	90.0	NS	2.144
25	N. Y.	80.8	83.8	81.0	82.0	83.8	81.6	81.4	NS	--
33	Pa.	53.0	53.4	51.6	56.2	44.2	51.6	54.8	NS	1.52
38A	Va.	13.8	22.4	19.2	18.6	22.0	26.8	14.0	NS	1.51
38B	Va.	84.8	81.6	84.6	79.8	88.2	83.6	82.6	NS	0.44

[a] At 5% point

[b] Soil known to be infested with *Pythium* spp.

Table 32. Relative value of different protectants in improving emergence from tomato seed, 1944.

	Number of times given treatment (Column 1) was superior to							Total[a] score
	Spergon	Arasan	Semesan	Yellow Cuprocide	New Improved Ceresan (dust)	New Improved Ceresan (dip)	Untreated check	
Spergon	-	-	-	-	-	-	2	2
Arasan	3	-	1	1		1	5	11
Semesan	1	-	-			1	5	7
Yellow Cuprocide	2	-	1	-	-	-	5	8
New Improved Ceresan (dust)	2	-	-	-	-	-	5	7
New Improved Ceresan (dip)	2	-	1	-	-	-	4	7
Untreated check	-	-	-	-	-	-	-	0

[a] Maximum value 30

Only 5 of the 12 tests included in the above tables showed significant differences between treatments. In 2 of these, all 6 protectant treatments gave significantly better stands than the checks. Five of the 6 treatments were superior to the check in 4 of the 5 significant trials and 4 treatments were superior in all 5 trials. Arasan dust showed a definite superiority over the other treatments in the total score, but Semesan, Yellow Cuprocide, and the Ceresan treatments all gave good results. Spergon, as in 1943, seemed definitely less effective than Arasan and others as a treatment for tomato seed.

The performance of New Improved Ceresan as a dust indicates that the use of this material in dust form may eventually replace the dip method. A general inspection of the data shows no evidence of seed injury in any trial and, as a protectant, it equaled the 1-1200 dip treatment and was about as effective as any treatment other than Arasan. Seed germinated in soil did not show any pronounced retardation in seedling emergence and growth. Since the Ceresan treatments combine effective surface disinfection with a good degree of protection against pre-emergence damping-off, they possess definite value in tomato seed treatment.

BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING,
BELTSVILLE, MARYLAND.

XII. SUMMARY

During 1944 a total of 236 uniform seed treatment tests were conducted by 40 cooperators located in 29 States and two Canadian provinces on 10 vegetable crops as part of a cooperative project started in 1940 under the auspices of a committee appointed by the American Phytopathological Society.

The crops tested this year were edible soybeans, beets, carrots, cucumber, lettuce, onions, peas, spinach, sweet corn, and tomato.

In each case seeds from a single lot were treated by a crop leader at specified dosages and in a uniform manner with three or more seed protectants and distributed to cooperators who conducted germination tests in soil using 5 replications of 100 seeds each.

The 1944 results for the several crops presented by the crop leaders are briefly summarized below:

Edible Soybeans: R. H. Porter obtained reports from 17 tests conducted by 16 cooperators in 14 States on Banzei soybeans treated with Arasan, Spergon, and Fermate, each at rates of 1 1/2 and 2 oz. per bushel. The results showed that seed protectants were of some value in about one-third of the tests conducted. Spergon (2 oz.) gave the most consistent increases in emergence. All of the plots in which significant differences occurred were located in States along the Atlantic Seaboard. The tests showed that if conditions are unfavorable for germination one could expect seed protectants to be of value even with seeds of high vitality, and if seeds of low vitality were used the benefits should be greater.

Beets: L. D. Leach summarizes the results of 31 tests conducted in 20 States and one Canadian Province on Detroit Dark Red Beet seeds treated with Arasan (.25%, .50% and 1.00%), Ceresan (1.0%), and Yellow Cuprocide (1.5%.) In most of the tests seed treated with Arasan, Ceresan, or Yellow Cuprocide gave significant increases in number of seedlings compared with untreated seed. Arasan at dosages of 0.5% and 1.0% gave the best results but it was not clear whether the differences between these two dosages justify the use of the 1.0%. The striking benefits from seed treatment in the 1944 beet tests in contrast to the limited benefits obtained in a similar test conducted in 1943 are attributed chiefly to differences in vitality and susceptibility to seed decay in the two seed lots used. These tests again demonstrate the principle that weak seed lots or weak varieties may show greater response to seed protectants than very vigorous seed lots or varieties.

Carrot: B. H. Davis reports from 19 tests conducted in 15 States and 1 Canadian Province on the variety Chantenay treated with Arasan and Spergon at .5% and .75%, Semesan at .42% and red copper oxide and zinc oxide at 1% by weight of seed. All treatments gave increased stands but Arasan gave slightly better results than the other materials.

Cucumber: Under the leadership of S. P. Doolittle cucumbers treated with Arasan (.3%), Yellow Cuprocide (1.0%), and Spergon (0.3%) were tested at 15 locations in 12 States. Beneficial effects from seed protectants were obtained in only about one-fourth of the tests conducted in 1944, whereas similar tests in 1943 gave beneficial effects in practically all cases, indicating that field conditions in 1944 were in general less favorable for seed decay and damping off. Difference in total scores of the treatments used in 1944 indicated that Semesan and Spergon were the most effective materials. Arasan, which in 1943 seemed definitely superior to other treatments, did not give particularly good results in the 1944 tests, while Spergon proved much more effective than in 1943.

Lettuce: Ten tests on lettuce conducted in 8 States using seeds treated with red copper oxide (2%), zinc oxide (2%), Semesan (2%), Arasan (2%), and Spergon (2%), and reported by G. K. Parris, seemed to show that seed treatment is a worthwhile procedure for lettuce. Spergon (2%) showed the most marked benefits in these tests although all treatments used proved superior to the untreated seed.

Onion: A. G. Newhall reports on damping-off control from 11 tests conducted in 8 States and on smut control from 2 tests in 2 States. Approximately one-third of the damping-off tests showed beneficial effect from Arasan (.5% and 1%), Fermate (.5% and 1%), and Semesan (.3% and .5%). No consistent improvement over the untreated seed resulted from Spergon (.5% and 1%), red copper oxide (.5% and 1%), or Vasco 4 (1% and 3%).

Moistening seed with 5% "Methocel" sticker and treating with Arasan, Fermate, or Thiosan (each at 100% and 75% by weight) in 2 tests gave good control of smut in both cases and gave some indication that the 100% dosage was slightly better than the 75% dosage.

Peas: W. T. Schroeder received reports on 53 tests conducted in 22 States and one Canadian Province with Thomas Laxton seed treated with red copper oxide (2 1/4 oz. per bu.), Arasan (1 1/2 and 2 oz.), and Spergon (1 1/2 and 2 oz.). All materials proved beneficial to emergence of peas. Spergon gave the best results. The 2 oz. per bushel dosage appeared to be no more effective than Spergon at 1 1/2 oz.

Spinach: G. K. Parris' summary of results from 36 tests conducted in 25 States and one Canadian Province with seeds treated with Arasan (.25% and .50% by weight), Fermate (.5% and .75%), and zinc oxide (1.5% and 2.0%), again supports our previous conclusion that seed treatment of spinach is a worthwhile practice. Arasan, Fermate, and zinc oxide at the dosages used gave significant increases in stands compared with untreated seed. Of the three materials used, zinc oxide consistently was better than Arasan and Fermate. The results suggested that zinc oxide may be used successfully at a dosage of 1.5% rather than 2.0% as recommended in previous years.

Sweet Corn: B. H. Davis reports that 30 tests conducted on the variety Ioana in 19 States and 1 Canadian Province using Arasan, Spergon, Semesan Jr., and Barbak C at 2 dosages (1.5 and 3.0 oz. per bu.) showed that seed treated with each of the protectants and at each dosage produced a significantly greater number of seedlings than untreated seed. The best results were obtained with Arasan, followed in order of decreased efficiency by Spergon, Semesan Jr., and Barbak C. In each case the higher dosage was better than the lower. The percentage of seedlings classified as "weak" was reduced by all treatments, and again Arasan gave the best results, followed in order of decreased efficiency by Spergon, Semesan Jr., and Barbak C. Thus seed protectants may benefit not only by increasing total emergence but also by reducing the percentage of weaklings in the final stand.

Tomato: S. P. Doolittle and F. S. Beecher received data from 12 tests conducted in 10 States with seeds treated with Spergon (.3% by weight of seed), Arasan (.3%), Semesan (.3%), Yellow Cuprocide (1.5%), New Improved Ceresan (.5%), and a 5-minute dip in a 1-1200 solution of New Improved Ceresan. Improved stands were obtained in only 42% of the tests. Where treatments were beneficial Arasan showed a definite superiority over the other materials but Semesan, Yellow Cuprocide, and New Improved Ceresan also gave good results. Spergon, as in 1943, seemed definitely less effective than the other materials for treating tomato seeds. The New Improved Ceresan was equally good whether used in dust form or as a dip.

SUBCOMMITTEE ON COORDINATION OF VEGETABLE SEED TREATMENT TESTS
C. M. Haenseler, Chairman.

PLANT DISEASE REPORTER SUPPLEMENT

Issued by

THE PLANT DISEASE SURVEY
DIVISION OF MYCOLOGY AND DISEASE SURVEY

Plant Industry Station Beltsville, Maryland

A CONTRIBUTION TO THE FUNGUS FLORA OF UTAH AND NEVADA

Arthur S. Rhoads[1]

Plant Disease Reporter
Supplement 162 June 15, 1946

The following fungi listed comprise miscellaneous collections during the latter part of 1944 and the first half of 1945. Records from a few collections made by others and turned over to the writer for determination have been included by reason of their interest. Unless otherwise stated, the fungi listed were collected in Utah, and by the writer.

Unfortunately, mycology has received very little attention in these States and little or nothing has been accumulated in the way of herbarium material of fungi at the various institutions in these respective States. Dr. L. O. Overholts expressed the opinion that Utah is more poorly represented in polypore collections in the various herbaria of the country than any other State. Utah is fortunate, however, in that Prof. A. O. Garrett, of Salt Lake City, has collected rusts and smuts over a period of approximately 40 years, and much of our knowledge of these groups of plant diseases in this State is based upon material collected by him.

Specimens of the fungi here reported have been deposited in the Mycological Collections at Washington and duplicates of most of them in

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[1] Formerly Pathologist with the Emergency Plant Disease Prevention Project, U. S. Bureau of Plant Industry, Soils, and Agricultural Engineering

the newly established herbarium of fungi at the Utah Agricultural Experiment Station. Parts of many of the collections have also been sent to various interested workers. Grateful acknowledgment is made to Dr. F. D. Kern for confirmation of the Gymnosporangiums, to Dr. G. B. Cummins for confirmation of many of the other rusts, and to Drs. W. A. Murrill and L. O. Overholts for identifications and confirmations of the polypores and agarics. The writer is also greatly indebted to Mr. Arthur H. Holmgren, Botanist of the Utah Agricultural Experiment Station, for his interest and kindness in identifying many of the host plants.

PHYCOMYCETES

Albugo candida (Pers. ex Lév.) O. Kuntze:

On Camelina microcarpa Anderjez., Logan, Cache Co., June 28.

Peronospora trifoliorum DBy.:

On Medicago sativa L., between Farmington and Kaysville, Davis Co., June 15. Specimens were also sent in from Salt Lake Co. earlier. This disease was troublesome in some plantings owing to abnormally heavy spring rainfall and necessitated early cutting of the first crop.

ASCOMYCETES

Cucurbitaria elongata (Fr.) Grev.:

On Acer negundo L., occurring abundantly on slash, above forks of creek 1 mile above Rotary Park in City Creek Canyon near Salt Lake City, Salt Lake Co., June 17.

Dasyscypha agassizii (Berk. & Curt.) Sacc.:

On Abies lasiocarpa (Hook.) Nutt., on stem of small dead tree, 1 1/2 miles west of Logan Canyon on Tony Grove Lake Road, Cache Co., June 24.

Dasyscypha arida (Phill.) Sacc.:

On fallen branches of Abies lasiocarpa (Hook.) Nutt., Tony Grove Lake, Bear River Range, and 1 1/2 miles west of Logan Canyon on Tony Grove Lake Road, Cache Co., June 24.

<u>Dasyscypha incarnata</u> Clements:

On <u>Pseudotsuga taxifolia</u> (Poir.) Britt., occurring on decorticated limbs, near Jardine Juniper 1 1/2 miles west of junction of Cottonwood Canyon with Logan Canyon, Cache Co., June 10.

<u>Dibotryon morbosum</u> (Schw.) Theiss. & Syd.:

On <u>Prunus virginiana</u> var. <u>demissa</u> (Nutt.) Torr., Logan Canyon and Cowley Canyon south of forks of Logan River, Sept. 10; Sardine Pass, Sept. 4; Green Canyon northeast of Logan and Smithfield Canyon, Apr. 29; High Creek east of Cove, June 3; and Cottonwood Canyon branch of Logan Canyon, June 10, all in Cache Co.; Ogden Canyon east of Ogden and Snow Basin Recreation Area 8 miles southwest of Huntsville, Weber Co., Sept. 17; Emigration Canyon east of Salt Lake City, May 19, and 1 mile above Rotary Park in City Creek Canyon near Salt Lake City, June 17, Salt Lake Co.; and Mt. Timpanogos on road from Wildwood, Utah Co., Aug. 20. This disease is extremely common and widespread in the mountains of northeastern Utah. Extensive lesions as much as 3 feet long sometimes occur on the stems and even those as large as 4 inches in diameter may be extensively deformed by the disease, which is exceedingly destructive to thickets of chokecherries.

<u>Discina ancilis</u> (Pers. ex Fr.) Sacc.:

On wet ground near edge of melting snow, Tony Grove Lake, Bear River Range, Cache Co., June 24.

<u>Erysiphe cichoracearum</u> DC.:

On <u>Artemisia dracunculoides</u> Pursh, 1/2 mile north of Tony Grove Lake, Bear River Range, Cache Co. Coll. by Wm. E. Rader, 1940.

On <u>Artemisia gnaphalodes</u> Nutt., Island in Logan River near Logan, Cache Co. Coll. by Wm. E. Rader, Oct. 23, 1940.

On <u>Aster coerulescens</u> DC., 5 miles up Logan Canyon, Cache Co., Oct. 15; Emigration Canyon east of Salt Lake City, Salt Lake Co., Oct. 8.

On <u>Cirsium pulchellum</u> (Greene) Woot. & Standl., 3 miles north of Glendale, Kane Co., Oct. 28.

On <u>Cynoglossum officinale</u> L., Cache Junction, Cache Co., Oct. 22.

Erysiphe cichoracearum cont.

On Grindelia squarrosa (Pursh) Dunal, Sardine Pass, 4 miles north of Mantua, Box Elder Co., Oct. 25; and Ogden Canyon east of Ogden, Weber Co., Sept. 17.

On Helenium montanum Nutt., 4 miles west of Logan, Cache Co., Oct. 22.

On Helianthus annuus L., Pleasant View, Weber Co., Sept 19; and North Centerville, Sept. 7, and Bountiful, Oct. 6, Davis Co.

On Mentha penardi (Briq.) Rydb., Spring Hollow and Guinavah Campsites in Logan Canyon, Cache Co., Oct. 15; and South Fork of Ogden River 5 miles east of Huntsville, Weber Co., Sept. 17.

On Plantago major L., South Fork of Ogden River 5 miles east of Huntsville, Weber Co., Sept. 17; and Right Fork of Hobble Creek east of Springville, Utah Co., Oct. 1.

On Polemonium foliosissimum A. Gray, Logan Canyon, Cache Co. Undated collection.

On Polemonium occidentale Greene, Boy's Camp on Right Fork of Logan River in Logan Canyon, Cache Co. Coll. by Dr. B. L. Richards, 1941.

On Rudbeckia occidentalis Nutt., 15 miles up Logan Canyon, Cache Co., Sept. 10; and Snow Basin Recreation Area 8 miles southwest of Huntsville, Weber Co., Sept. 17.

On Viguiera multiflora (Nutt.) Blake, Ogden Canyon east of Ogden, Weber Co., Sept. 17; and Parley's Canyon east of Salt Lake City, Salt Lake Co., Oct. 8 .

Erysiphe polygoni DC.:

On Aquilegia caerulea James, 5 miles up Logan Canyon, Cache Co., Oct. 15.

On Clematis ligusticifolia Nutt., Ogden Canyon east of Ogden, Weber Co., Sept. 3.

On Delphinium sp. (cult. perennial), Logan, Cache Co., July 19.

On Polygonum aviculare L., Logan, Cache Co., Oct. 16.

On Polygonum buxiforme Small, near Cache Junction, Cache Co., Oct. 22.

Gyromitra caroliniana Fr.:

On wet ground near edge of melting snow, Tony Grove Lake, Bear River Range, Cache Co., June 24.

Helotium virgultorum (Vahl ex Fr.) Karst.:

On piece of fallen branch of Populus tremuloides Michx., 1 1/2 miles west of Logan Canyon on Tony Grove Lake Road, Cache Co., June 24.

Hysterographium bakeri Earle:

On decorticated standing trunk of Cercocarpus ledifolius Nutt., near Jardine Juniper on crest of ridge 1 1/2 miles west of junction of Cottonwood Canyon with Logan Canyon, Cache Co., June 10.

Lachnellula chrysophthalma (Pers.) Karst.:

On decorticated fallen trunk of Picea engelmanni Parry, Tony Grove Lake, Bear River Range, Cache Co., June 24.

Lasiobotrys symphoricarpi Syd.:

On leaves of Symphoricarpos vaccinioides Rydb., Spring Hollow in Logan Canyon, Cache Co. Coll. by Mr. Arthur H. Holmgren, July 15, 1944.

Lophodermium tumidum (Fr.) Rehm:

On old fallen leaves of Amelanchier florida Lindl., Emigration Canyon east of Salt Lake City, Salt Lake Co., Oct. 8.

Melanomma nitida Ell. & Ev.:

On dead stems of broken bush of Artemisia tridentata Nutt., Blacksmith Fork east of Hyrum, Cache Co., May 5.

Microsphaera alni DC. ex Wint.:

On Alnus tenuifolia Nutt., associated sparingly with Phyllactinia corylea Pers. ex Karst., South Fork of Ogden River 5 1/2 miles east of Huntsville, Weber Co., Sept. 17; and Right Fork of

Microsphaera alni cont.

Hobble Creek east of Springville, Utah Co., Oct. 1.

On *Quercus gambelii* Nutt., North Ogden, Weber Co., Sept. 14; and Right Fork of Hobble Creek east of Springville, Utah Co., Oct. 1.

Microsphaera diffusa Cke. & Pk.:

On *Symphoricarpos vaccinioides* Rydb., Ogden Canyon east of Ogden, Weber Co., Sept. 3.

Mycosphaerella spleniata (Cke. & Pk.) House:

On *Quercus gambelii* Nutt., Bullion Canyon 4 miles west of Marysvale, Piute Co., Oct. 27. Occurring abundantly on old fallen leaves.

Phyllactinia corylea Pers. ex Karst.:

On *Acer negundo* L., Logan Canyon, Cache Co. Coll. by Dr. B. L. Richards, 1941.

On *Alnus tenuifolia* Nutt., associated with *Microsphaera alni* DC. ex Wint., South Fork of Ogden River 5 1/2 miles east of Huntsville, Weber Co., Sept. 17; and Right Fork of Hobble Creek east of Springville, Utah Co., Oct. 1.

On *Cornus stolonifera* Michx., 8 miles up Logan Canyon, Cache Co., Oct. 15; Beaver Creek 10 miles east of Huntsville, Weber Co., Oct. 1; and Bullion Canyon 4 miles west of Marysvale, Piute Co., Oct. 15.

On *Populus angustifolia* James, 3 miles north of Glendale, Kane Co., Oct. 28.

On *Shepherdia argentea* Nutt., 3 miles north of Marysvale, Piute Co., Oct. 27. Occurring in profusion.

Podosphaera oxyacanthae (DC.) DBy.:

On *Prunus avium* L., near Kaysville, Davis Co., July 22.

On *Prunus cerasus* L., near Kaysville, Davis Co., July 22.

On Duke cherry (*Prunus avium* X *P. cerasus*), North Ogden, Weber Co., Sept. 1.

Pseudopeziza medicaginis (Lib.) Sacc.:

On Medicago sativa L., La Verkin, Washington Co., Nov. 1.

Rhytisma salicinum Pers. ex Fr.:

On Salix caudatum (Nutt.) Heller, 6 miles up Logan Canyon, Cache Co., Sept. 10.

On Salix scouleriana Barratt, Cottonwood Canyon branch of Logan Canyon, Cache Co., Sept. 10; and Snow Basin Recreation Area 8 miles southwest of Huntsville, Weber Co., Sept. 17. Occurring abundantly in both cases.

Sphaeropsis sp.:

On dead twigs of witches' broom on Ephedra nevadensis S. Wats. caused by Peridermium ephedrae, Valley of Fire southwest of Overton, Clark Co., Nevada, Apr. 14.

Sphaerotheca humuli var. fuliginea (Schl.) Salm.:

On Agastache urticifolia (Benth.) O. Kuntze, Snow Basin Recreation Area 8 miles southwest of Huntsville, Weber Co., Sept. 17.

On Senecio hydrophilus Nutt., 2 miles north of Marysvale, Piute Co., Oct. 27.

On Senecio integerrimus Nutt., Green Canyon northeast of Logan, Cache Co., May 30.

On Senecio serra Hook., Snow Basin Recreation Area 8 miles southwest of Huntsville, Weber Co., Sept. 17.

On Taraxacum vulgare (Lam.) Schr., Logan, Cache Co., Oct. 16; Ogden, Sept. 22; Snow Basin Recreation Area 8 miles southwest of Huntsville, Sept. 17; Weber Co.; and Mapleton, Utah Co., Sept. 30.

Syncarpella tumefaciens (Ell. & Harkn.) Theiss. & Syd.:

On Artemisia tridentata Nutt., 2 1/2 miles west of Pequop Summit, Elko Co., Nevada, Nov. 10, occurring on fusiform swellings on living and dead stems. Also in Blacksmith Fork east of Hyrum, Cache Co., May 5, occurring on dead stems and apparently killing them.

Teichospora mammoides Ell. & Ev.:

On dead stems of Opuntia acanthocarpa Engelm. & Bigel., between St. George and Veyo, Washington Co., Apr. 15. Associated with Phyllosticta cacti (Berk.) Archer.

Teichospora megastega Ell. & Ev.:

On Ephedra nevadensis S. Wats., 20 miles north of Beatty, Nye Co., and near Goldfield, Esmeralda Co., Nevada, Nov. 4, occurring commonly on dead stems. Also 8 1/2 miles west of Hurricane, Washington Co., Apr. 10. Apparently rare in Utah.

On Ephedra viridis Coville, 15 miles west of Santa Clara, Washington Co., Aug. 13. On dead stems.

Teichospora variabilis Ell. & Ev.:

On dead stems of Artemisia tridentata Nutt., near mouth of Green Canyon northeast of Logan, Cache Co., May 30.

Teichospora sp. (probably undescribed):

On Juniperus utahensis (Engelm.) Lemm., Arches National Monument, Grand Co., May 17. Frequent on decorticated dead twigs and branches of living trees.

Thrystroma utahense (Sacc.) Petr.:

On dead twigs of Chrysothamnus sp., Cedar Canyon east of Cedar City, Iron Co., Apr. 9.

Uncinula salicis DC. ex Wint.:

On Populus tremuloides Michx., Ogden Canyon east of Ogden, Sept. 3; Snow Basin Recreation Area 8 miles southwest of Huntsville, Sept. 17, Weber Co.

On Salix glaucops Anders., Spring Hollow Campsite in Logan Canyon, Cache Co., Oct. 15.

UREDINALES

Cronartium occidentale Hedgc., Bethel & Hunt, II, III:

On Ribes aureum Pursh, Ogden Canyon east of Ogden, Weber Co., Sept. 3; and 2 miles south of Panguitch, Garfield Co., Oct. 28.

Cumminsiella sanguinea (Pk.) Arth., II, III:

On Mahonia repens (Lindl.) Don, 6 miles up Logan Canyon (Oct. 15) and near Logan (May 26), Cache Co.; Parley's Canyon and Millcreek Canyon (Oct. 8) and above Rotary Park in City Creek Canyon (June 17) near Salt Lake City, Salt Lake Co.; Bullion Canyon 4 miles west of Marysvale, Piute Co., Oct. 27; Crandall Canyon above Castlegate, Carbon Co., collected by Arthur H. Holmgren, June 29, 1944.

Gymnosporangium betheli Kern, I, III:

On Crataegus rivularis Nutt., occurring more or less abundantly, and often in great profusion, in places at various points in northern Utah as follows:

Utah Co.:
Mt. Timpanogos along road from Wildwood, Aug. 20; Right Fork of Hobble Creek east of Springville, Oct. 1; and 2/5 mile and again 4 miles south of Thistle, Oct. 26.

Morgan Co.:
Between Devil's Gate and Gateway along the Weber River, Sept. 24.

Weber Co.:
South Fork of Ogden River 6 miles east of Huntsville, Sept. 17, and Eden, Sept. 24.

Box Elder Co.:
Box Elder Canyon between Brigham City and Mantua, Sept. 4.

Cache Co.:
Various points in Logan Canyon and along Right Fork of Logan River near junction with Cowley Canyon road, Sept. 10.

This rust frequently occurs more or less profusely on leaves and fruits, and trees are sometimes so severely infected that the foliage turns yellow in midsummer. Specimens collected late in the season were characterized by a very lacerate condition of

Gymnosporangium betheli cont.

the tubular aecia indicative of G. tubulatum, which has not been reported from Utah. Specimens from 10 collections made from midsummer to fall were all considered to be the same rust by Dr. F. D. Kern, who concluded that G. betheli and G. tubulatum probably are not separate species and should be combined.

On Juniperus scopulorum Sarg., occurring more or less abundantly, and often in great profusion, at various points in northern Utah as follows:

Utah Co.:
2/5-3/5 mile south of Thistle, Apr. 18 and May 8; 4 miles southeast of Cotton on U. S. No. 90, May 17; and on flank of Mt. Timpanogos, May 13, occurring sparingly except near Thistle, where it was abundant on several young trees occurring in close proximity to hawthorns (Crataegus rivularis Nutt.) with fruits heavily infected on Oct. 26.

Salt Lake Co.:
Parley's Canyon east of Salt Lake City, occurring very sparingly but juniper very scarce in this canyon.

Weber Co.:
South Fork of Ogden River 6.5 miles east of Huntsville, May 21, occurring abundantly on limbs of a single large tree surrounded by Crataegus rivularis and infrequent on others but juniper very scarce.

Cache Co.:
Occurring in great profusion at various points for a distance of 15 miles up Logan Canyon, Apr. 28, May 3, May 27, June 10, and June 24; also abundant in Blacksmith Fork east of Hyrum, May 5, and in Smithfield Canyon east of Smithfield, Apr. 29 and May 30; also a trace in Green Canyon northeast of Logan, Apr. 29.

The telia of this and other species of Gymnosporangium were about all washed away by June 10 as a result of repeated heavy rains during May and the first few days of June. G betheli is a rather variable rust, with a number of different manifestations on various parts of trees. The description stating that the telia occur in irregular, gall-like knots, usually breaking forth in succession along the branch, is woefully inadequate for this rust. It commonly produces innumerable small lesions on the twigs and small branches, long, more or less fusiform lesions on the limbs, and occasionally extensive lesions or series of lesions up to 3 or more feet long on the trunks of young trees,

Gymnosporangium betheli cont.

and has even been observed fruiting on trunks of trees as large as 5 inches in diameter. In some cases only very recent infections were found on twigs and small branches, in others only old lesions on limbs or trunks, while still others may have both. On one tree with numerous small twig infections in Logan Canyon even a few berries bore telia of this rust. Severity of infection was found to be closely correlated with the proximity of the alternate host, Crataegus rivularis. In the case of lesions on limbs the older central areas of bark become roughened and die in time and become blackish, but the rust usually continues to develop new telia from year to year from the callus formed along the living margins until the branch dies. In many cases, however, the rust kills attacked limbs quite extensively. Old dead lesions closely simulate black knot or chokecherry in general appearance. This rust often is associated with G. nelsoni Arth. and when but very recent infections of both occur together on the foliage sprays and smaller twigs, separation by visual methods presents difficulties. Lesions on older twigs and branches usually are characterized by a series of nodular excrescences closely aggregated into fusiform swellings, but these do not always develop, particularly with infections of very recent origin. New excrescences appear to develop rapidly following the formation of telia on those of the preceding year. The development of a new series of excrescences by this rust is not unlike that of new hypertrophied areas of black knot of chokecherry. This rust has never been observed to attack Utah juniper.

Gymnosporangium inconspicuum Kern, III:

On Juniperus utahensis (Engelm.) Lemm., occurring abundantly on foliage sprays on one large tree bearing numerous globose, woody galls of G. nelsoni Arth., 2 miles north of Pintura, Washington Co., Apr. 9.

Gymnosporangium juvenescens Kern, III:

On Juniperus scopulorum Sarg., causing the development of more or less compact witches'-brooms with the foliage usually, but not always, reverting to the subulate, juvenile type. Brooms caused by this rust were found occurring at a number of points up Logan Canyon in Cache Co., namely Source of Logan City Water Supply (Apr. 28), Preston Valley Trail 9 miles up the Canyon (May 3), above Guinavah Campsite (May 27), Chokecherry Camp Ground, Cottonwood Canyon branch of Logan Canyon, and near the Jardine Juniper near the crest of a rocky ridge 1 1/2 miles west of the junction of Cottonwood Canyon with Logan Canyon (June 10). Brooms from nearly

Gymnosporangium juvenescens cont.

all points showed good development of telia except for one collection made as late as June 10, which showed the scars where the telial cushions had been produced but the telia had been completely washed away by the abnormally heavy rainfall during May and early June. Other brooms collected near the Jardine Juniper on this date, however, still showed good development of telia in the compact interiors but the spores had germinated. Several brooms with telia just beginning to develop well were also found on trees at a fairly high elevation in Smithfield Canyon, Cache Co., on April 29, when snow was still present nearby. A single broom with good development of telia also was found on a young planted tree in the city park at Price, Carbon Co., May 8. Two brooms not yet fruiting were found on one large tree at a fairly high elevation near Long Valley Junction on the Dixie National Forest, Kane Co., Apr. 17, telial production being retarded both by earliness of season and high altitude.

As a rule but one or two of these rust brooms are found on single trees but occasionally several trees, each with from one to a few brooms, may occur fairly close together. Seven trees with rust brooms were found in the vicinity of the Jardine Juniper and one of these trees had 6 living brooms and 2 dead ones. Some of the brooms on trees in this vicinity were of considerable age. The Jardine Juniper, now nearly dead, has a diameter of 8 feet and has been estimated to be from 3200-3500 years old and is claimed to be the oldest tree of its kind. This broom-forming rust apparently never occurs on J. utahensis, which is frequently associated with J. scopulorum. One broom with good telial development on the foliage was found on a tree with numerous lesions of G. betheli and this rust was even fruiting on the branch from which the witches'-broom had developed.

Gymnosporangium kernianum Bethel, III:

On Juniperus utahensis (Engelm.) Lemm., causing compact witches'-brooms with a slight reduction in leaf size but no reversion of the foliage to the subulate, juvenile type. Brooms with good telia developed on the foliage were observed near the west entrance to Zion National Park, Washington Co., at the east entrance on the Washington-Kane Co. line, and at points 8 and 10 miles north of Kanab, Kane Co., Apr. 16 and 17. Bethel (Mycologia 3: 157. 1911), in his description of these brooms, gives the size as ranging from 2 inches to 2 feet in diameter. However, the brooms seen north of Kanab were of giant size. One tree about 2 ft. in diameter had an old broom fully 8 ft. in diameter formed in the upper part of one of two upright main limbs, the other having

Gymnosporangium kernianum cont.

been off. Two other trees, equally large, each had an old broom, respectively 8 and 10 ft. in diameter, formed on the lower limbs. In small brooms the branches are reduced to a compact, rounded mass so dense that the interior twigs die and remain as a mass of litter persisting for years. In these giant brooms, however, they had grown so long that the main limbs had become bare and the compact masses of smaller brooms were borne on the terminal portions of the various subdivisions, the whole united into a compound witches'-broom. When the great age and slow rate of growth of these trees are considered, such giant witches'-brooms doubtless will prove to be at least a hundred or more years old.

Smaller brooms with good telial development were collected subsequently at a point 10.7 miles south of Kane Spring Turnout, May 12, Allen Canyon Road 14 miles west of Blanding, at the eastern boundary of the La Sal National Forest 17.6 miles west of Blanding, May 13, and 1/2 mile east of La Sal (7,000 ft. elev.), San Juan Co., May 16. In the latter case 2 compact brooms with good telia of this rust occurred on a tree with several open-type brooms caused by G. speciosum Pk.; in fact the latter rust was fruiting on the stems of both the G. kernianum brooms. Five trees, each with one or more brooms, some of which exhibited good telial production, also were found on scattered trees in one area of the Arches National Monument, Grand Co., May 17. This rust apparently does not occur on J. scopulorum, the rusts causing the brooms on these respective trees being considered distinct species.

Gymnosporangium libocedri (P. Henn.) Kern, III:

On Libocedrus decurrens Torr., occurring rather frequently on a number of trees a few miles northeast of Lake Tahoe, Lyon Co., Nevada, Nov. 8, as evidenced by the witches'-broom formations on the branches. This rust does not appear to have been reported as occurring in this State.

Gymnosporangium nelsoni Arth., III:

On Amelanchier florida Lindl., at various points in Logan Canyon (Aug. 6, Sept. 10 and Oct. 15) and in Cowley Canyon south of forks of Logan River (Sept. 10), Cache Co.; Ogden Canyon east of Ogden, Weber Co., Sept. 3; Mt. Timpanogos along road from Wildwood, Utah Co.; Aug. 20, and on top of a ridge 5 1/2 miles west of Panguitch, Garfield Co., Oct. 27. This rust is extremely common and widespread on foliage and fruit.

Gymnosporangium nelsoni cont.

On *Juniperus scopulorum* Sarg., as follows:

Kane Co.:
5 1/2 miles northeast of Glendale, Apr. 17.

Garfield Co.:
1.7 miles south of Hatch, Apr. 17.

Carbon Co.:
On young trees planted in city park at Price, May 8, and between Royal and Soldier Summit, May 17.

Utah Co.:
4 miles south of Cotton on U. S. Highway No. 90, May 17, and on flank of Mt. Timpanogos along road from Wildwood, May 18.

Weber Co.:
South Fork of Ogden River 6-7 miles east of Huntsville, May 21.

Cache Co.:
Various points up Logan Canyon, Apr. 28, May 3 and June 10; junction of Right Fork of Logan River with Cowley Canyon Road, May 3 and May 27; Green Canyon northeast of Logan, Apr. 29 and May 30; Smithfield Canyon east of Smithfield, Apr. 29; and High Creek 4 1/2 miles east of Cove, June 3. As a general rule, this rust does not appear to occur anywhere near as abundantly on this host as it does on *J. utahensis* and the galls are much smaller and more cerebroid. In the northern part of Utah this rust frequently occurs in association with *G. betheli*.

Nevada:

A collection of this rust was made for the writer by Dr. Bassett Maguire and Mr. Arthur H. Holmgren at Cherry Creek, Quinn Canyon Range, Nye Co., June 8. Not recorded in Arthur's Rust Manual as occurring on juniper in this State.

On *Juniperus utahensis* (Engelm.) Lemm., occurring abundantly, and often in great profusion, throughout much of southwestern and southeastern Utah, where this host is extremely common. Collections were made as follows:

Washington Co.:
2 miles north of Pintura, Anderson's Ranch 3 miles north of Toquerville, 1.4-1.6 miles northeast of Leeds, Silver Reef Mine Road 1.5 mile north of Leeds, 5, 10 and 15 miles northwest of Santa Clara and continuing along U. S. No. 91 Highway

Gymnosporangium nelsoni cont.

to a point 8 miles north of the Utah-Arizona State line, where the host stopped; also half-way between St. George and Veyo and on hillside southwest of Veyo, and starting again between Rockville and Springdale and occurring abundantly through Zion National Park to the east boundary at the Washington-Kane Co. line, Apr. 9-16.

Kane Co.:

Occurring more or less abundantly, and often in great profusion, throughout the western part, collections being made at intervals from the western boundary east to Mt. Carmel Junction and thence southward to the Utah-Arizona State line 3 1/2 miles south of Kanab, and northward from Mt. Carmel Junction to a point 5 1/2 miles northeast of Glendale (Apr. 16-17), where, at the higher elevation, J. utahensis was replaced by J. scopulorum.

Cache Co.:

Green Canyon northeast of Logan, Apr. 29.

Carbon Co.:

10-11 miles southeast of Price, May 9.

Emery Co.:

25 miles southeast of Price, May 9.

Grand Co.:

13 1/2 miles northwest of Moab, May 9, from Castleton to a point 5 miles northwest, May 11, and at Arches National Monument, May 17.

San Juan Co.:

Of widespread occurrence throughout much of this county wherever Utah juniper occurred and was examined, collections being made at points 8.2 and 12.8 miles southeast of Moab, 9.8 and 10.7 miles south of Kane Spring Turnout, 11 and 9 miles north and 2 1/2 miles east of Monticello, at intervals along the road to Blanding 22 miles south of Monticello, at intervals to a point at 7000 ft. elev. west of Blanding, where the upper limit of Utah juniper is reached, and southward from Blanding to a point 11 miles north of Bluff, where the country with scattered Utah juniper drops off to desert; also at the upper limit of this tree 1/2 mile east of La Sal, May 12-17.

In some localities in Washington and Kane Counties in southwestern Utah, and in Grand and San Juan Counties in southeastern Utah this rust was so abundant that galls occurred by the hundreds on

Gymnosporangium nelsoni cont.

individual trees. These mostly ranged in size from minute ones just large enough to develop one or two telial horns to globose woody galls about an inch in size. Numerous galls up to 2 and even 3 1/2 inches in diameter were seen on the larger branches, and even galls up to 4 1/2 inches across were seen on the sides of large limbs or trunks. Arthur's Rust Manual gives the size as ranging up to 5 cm. Galls developing on twigs invariably are small since these parts are soon killed by the rust. Galls on the larger branches or trunks often attain considerable size and age. Telia were well developed during the first half of April, when the collections in southwestern Utah were made, except at elevations much above 5,000 ft., where telial production was greatly delayed by cold and was just beginning. As a general rule, the small galls develop telia earlier than the large ones. In a number of localities where infections had not developed within the last few years the galls were mostly dead.

Nevada:

A fine collection of this rust was made for the writer by Dr. Bassett Maguire and Mr. Arthur H. Holmgren at Burnt Creek Canyon, Quinn Canyon Range, Nye Co. Not recorded in Arthur's Rust Manual as occurring on juniper in this State.

Gymnosporangium speciosum Pk., III:

On Juniperus utahensis (Engelm.) Lemm., occurring in great profusion on the fusiform swellings of branches of a series of open-type witches'-brooms involving most of the living branches on a single tree 1/2 mile east of La Sal, San Juan Co., May 16. The orange-yellow telia developed as frilly outgrowths extruded in more or less linear arrangement through the bark, which was abnormally thickened and deeply fissured. They occurred most abundantly on the twigs and smaller branches of the brooms but were observed on one old branch 2 1/2 inches in diameter. Telial development of this rust even occurred on the larger branches of the two compact witches'-brooms which first attracted attention to this tree. It was abundant on all of the open-type brooms except two which were largely dead from the rust. While this rust has been reported as occurring on fusiform swellings, no mention has been made that it stimulates the development of witches'-brooms.

Melampsora albertensis Arth., II:

On Populus tremuloides Michx., 6 miles up Logan Canyon, Cache Co., Sept. 10; Ogden Canyon east of Ogden, Weber Co., Sept. 3; Mt.

Melampsora albertensis cont.

Timpanogos near Wildwood, Utah Co., Aug. 20.

Melampsora ribesii-purpureae Kleb., II:

On Salix amygdaloides Anders., 1 1/2 miles east of forks of Logan River, Logan Canyon, Cache Co., Sept. 10.

On Salix caudata (Nutt.) Heller, 6 miles up Logan Canyon, Cache Co., Sept. 10.

On Salix lutea Nutt., near Fruitland, Duchesne Co. Coll. by M. B. Linford, Aug. 7, 1927.

On Salix scouleriana Barratt, Box Elder Canyon, between Brigham City and Mantua, Box Elder Co., Sept. 4; Ogden Canyon east of Ogden, Weber Co., Sept. 3; near head of American Fork Canyon, Utah Co., Aug. 20.

Melampsorella cerastii (Pers.) Schroet., I:

On Abies concolor Lindl. & Gord., near head of American Fork Canyon, Utah Co., Aug. 20. Forming witches'-brooms with abundant aecia on 4 trees.

Peridermium ephedrae Cke., I:

On Ephedra nevadensis S. Wats., Valley of Fire southwest of Overton, Clark Co., Nevada, Apr. 14. A single witches'-broom was found in which all the aecia but those on a few twigs had weathered away, leaving lenticular ruptures in the cortex of the twigs, through which aecia had developed. New to the State Flora.

Phragmidium montivaguum Arth., II, III:

On Rosa woodsii Lindl., occurring commonly at various points up Logan Canyon, Cache Co., Aug. 6 and Sept. 10; also at Ogden, Weber Co., Sept. 18. Not reported previously on this host in Utah.

Phragmidium occidentale Arth., II, III:

On Rubus parviflorus Nutt., Ogden Canyon east of Ogden, Weber Co., Sept. 3; City Creek Canyon near Salt Lake City, Salt Lake Co., Aug. 13.

Phragmidium rubi-idaei (DC.) Karst., III:

On Rubus idaeus var. aculeatissimus Regel & Tiling, 14 miles up Logan Canyon, Cache Co., Sept. 10.

Puccinia absinthii (Hedw. f.) DC., II, III:

On Artemisia gnaphalodes Nutt., Island in Logan River, near Logan, Cache Co. Coll. by B. L. Richards, Oct. 4, 1941. Not reported previously on this host in Utah.

On Artemisia tridentata Nutt., 7 miles up Logan Canyon, Cache Co., Oct. 15; Hobble Creek Canyon east of Springville, Utah Co., Oct. 1; 5 1/2 miles west of Panguitch, Garfield Co., Oct. 27; also near Steamboat Hot Springs, Storey Co., and Pequop Summitt, Elko Co., Nevada, Nov. 8 and 10.

On Artemisia tridentata var. rothrockii Hall & Clements, near head of Beaver Creek 12 miles northeast of Huntsville, Weber Co., Sept. 24.

Puccinia aemulans Syd., II, III:

On Viguiera multiflora (Nutt.) Blake, 14 miles up Logan Canyon, Cache Co., Sept. 10; Ogden Canyon east of Ogden, Weber Co., Sept. 3; Parley's Canyon east of Salt Lake City, Salt Lake Co., Oct. 8.

Puccinia aristidae Tracy, II, III:

On Distichlis stricta (Torr.) Rydb., 4 miles west of Smithfield, Cache Co., Oct. 26; Redmond and Salina, Sevier Co., Oct. 26; also 2 miles west of Fallon, Churchill Co., and at Reno Hot Springs, Washoe Co., Nevada, Nov. 5 and 8.

Puccinia atrofusca (Dudl. & Thomp.) Holw., II, III:

On Carex geyeri Boott, 6 miles up Logan Canyon, Cache Co., Oct. 15. Not reported previously on this host in Utah.

Puccinia balsamorhizae Pk., II, III:

On Balsamorhiza sagittata (Pursh) Nutt., 6 miles up Logan Canyon, Cache Co., Oct. 15.

Puccinia balsamorhizae cont.

On Wyethia amplexicaulis Nutt., Sardine Pass., 4 miles north of Mantua, Box Elder Co., Oct. 25.

Puccinia bardanae (Wallr.) Cda., II, III:

On Arctium minus Schk., 5 miles up Logan Canyon, Cache Co., Oct. 15; Box Elder Canyon, between Brigham City and Mantua, Box Elder Co., Sept. 4; Ogden Canyon east of Ogden, Weber Co., Sept. 3; South Fork of Ogden River 5 1/2 miles east of Huntsville, Weber Co., Sept. 17; City Creek Canyon near Salt Lake City, Salt Lake Co., Aug. 13. A large collection of this rust, made by Dr. B. L. Richards at Nibley, Cache Co., Sept. 12, 1941, was found later in working over some unidentified collections. This rust, which has not been reported previously as occurring in Utah, appears to be well established in the northeastern part. Since Arthur's Rust Manual gives North Dakota as the western limit of distribution, these collections extend the range more than 500 miles southwestward.

Puccinia calochorti Pk., I, III:

On Calochortus nuttallii T. & G., near mouth of Green Canyon northeast of Logan, June 2; Logan, June 28, Cache Co.

Puccinia caricis urticata (Kern) Arth., II:

On Carex nebraskensis Dewey, near Cache Junction and at State Fish Hatchery west of Logan, Cache Co., Oct. 22; north of Glendale, Kane Co., Oct. 28.

On Carex sp., State Fish Hatchery west of Logan, Cache Co., Oct. 22.

Puccinia cirsii Lasch, II, III:

On Cirsium arizonicum (A. Gray) Petrak, Zion Canyon, Zion National Park, near Springdale, Washington Co., Oct. 29. Not reported previously on this host in Utah.

On Cirsium undulatum (Nutt.) Spreng., Ogden, Weber Co., Sept. 18.

Puccinia cnici Mart., II, III:

On Cirsium lanceolatum (L.) Hill, 14 miles up Logan Canyon, Cache

<u>Puccinia cnici</u> cont.

Co., Sept. 10; South Fork of Ogden River 6 miles east of Huntsville, Weber Co., Sept. 17; Right Fork of Hobble Creek east of Springville, Utah Co., Oct. 1.

<u>Puccinia conspicua</u> (Arth.) Mains, I:

On <u>Helenium hoopsei</u> A. Gray, Schuman's Gulch, La Sal Mts., Grand Co., at 9000 ft. elev. Coll. by Dr. Bassett Maguire, July 21, 1933. New to the Utah Flora.

<u>Puccinia evadens</u> Hark., II:

On <u>Baccharis emoryi</u> A. Gray, Zion Canyon, Zion National Park, near Springdale, Oct. 29, and in 2 localities at La Verkin, Washington Co., Nov. 1. Causing fusiform swellings and witches'-brooms on stems, the systemic, caulicolous habit of the uredinial stage being unusual. When in this county again on Apr. 14 old brooms and fusiform swellings were observed occurring abundantly at one locality east of Rockdale and at Zion Lodge in Zion National Park, the latter about a mile from the place where the rust was collected earlier. New to the Utah Flora.

<u>Puccinia globosipes</u> Pk., II, III:

On <u>Lycium andersonii</u> A. Gray, 5 miles west of Fallon, Churchill Co., Nov. 5, and in Valley of Fire southwest of Overton, Clark Co., Apr. 14, Nevada; also northeast of La Verkin and 2.6 miles north of Utah-Arizona State line on U.S. Highway No. 91, Washington Co., Apr. 10 and 15.

On <u>Lycium torreyi</u> A. Gray, Overton, Moapa Valley, Clark Co., Nevada, Apr. 13.

<u>Puccinia grindeliae</u> Pk., III:

On <u>Chrysothamnus nauseosus</u> subsp. <u>graveolens</u> (Nutt.) H. & C., Zion Canyon, Zion National Park, near Springdale, Washington Co., Oct. 29. Abundant.

On <u>Gutierrezia sarothrae</u> (Pursh) Britt. & Rusby, same locality and date.

Puccinia grindeliae cont.

On Actinea leptoclada ivesiana (Greene) Macbr., Comb Wash Ridge between Bluff and Mexican Hat, San Juan Co. Coll. by Arthur H. Holmgren, May 20, 1944; also 9 miles north of Monticello, San Juan Co., May 12. In the latter collection the rust was confined to old dead overwintered basal leaves. While infections had developed on the young leaves, it was too early for sporulation of the rust on these.

Puccinia harknessii Vize, II, III:

On Lygodesmia spinosa Nutt., 1 1/2 miles north of the University of Nevada, Reno, Washoe Co., Nevada, Nov. 7.

On Stephanomeria tenuifolia (Torr.) H. M. Hall, Zion Canyon, Zion National Park, near Springdale, Washington Co., Oct. 26.

Puccinia helianthi Schw., II, III:

On Helianthus annuus L., Toquerville, Washington Co., Nov. 2.

Puccinia heucherae (Schw.) Diet., III:

On Mitella stauropetala Piper, Ogden Canyon east of Ogden, Weber Co., Sept. 3. Not reported previously on this host in Utah.

Puccinia hieracii (Schum.) Mart., II, III:

On Agoseris (an apomict), occurring on leaves, stems and flower-heads, Logan, Cache Co., June 28.

On Crepis occidentalis Nutt., occurring on leaves, stems and flower-heads. Associated with the preceding.

On Taraxacum vulgaris (Lam.) Schr., 5 miles up Logan Canyon, Cache Co., Oct. 15; Ogden Canyon east of Ogden and Snow Basin Recreation Area 8 miles southwest of Huntsville, Weber Co., Sept. 3 and 7; Parley's Canyon east of Salt Lake City, Salt Lake Co., Oct. 8; La Verkin, Washington Co., Nov. 1.

Puccinia holboellii (Horenem.) Rostr., O, III:

On Arabis holboellii Horenem., junction of Lake Blanch Road in Big

Puccinia holboellii cont.

Cottonwood Canyon near Holladay, May 20, and City Creek Canyon near Salt Lake City, May 21, Salt Lake Co.; Cottonwood Canyon branch of Logan Canyon and Guinavah Campsite in Logan Canyon, June 10 and May 27, Cache Co.

On Arabis holboellii var. retrofracta (Grah.) Rydb., on mountain bench and ravine east of Logan, Cache Co., May 26.

On Arabis sp., La Sal National Forest 27 miles west of Blanding, San Juan Co., May 15.

Puccinia iridis (DC.) Wallr., II, III:

On Iris missouriensis Nutt., 4 miles north of Circleville, Piute Co., Oct. 27. New to the Utah Flora.

Puccinia jonesii typica Arth., 0, I, III:

On Lomatium dissectum (Nutt.) M. & C. var. multifidum (Nutt.) M. & C., Big Cottonwood, Millcreek and City Creek Canyons near Salt Lake City, Salt Lake Co., May 20 and 21; Logan Canyon, Cache Co., May 27.

On Lomatium simplex (Nutt.) Macbr., Logan, Cache Co., May 9 and June 28.

Puccinia malvacearum Bert., III:

On Althea rosea (L.) Cav., South Ogden, Weber Co., June 18; Logan, Cache Co., June 30.

On Malva rotundifolia L., South Fork of Ogden River 5 miles east of Huntsville and at Pleasant View, Weber Co., Sept. 17 and 19; Right Fork of Hobble Creek east of Springville, Utah Co., Oct. 1; Leeds and Santa Clara, Washington Co., Oct. 30, also at Reno, Washoe Co., Nevada, Nov. 7. A very common rust on this host.

Puccinia menthae Pers., III:

On Mentha penardi (Briq.) Rydb., Right Fork of Hobble Creek east of Springville, Utah Co., Oct. 1.

Puccinia millefolii Fckl., III:

On Achillea lanulosa Nutt., 14 miles up Logan Canyon, Cache Co., Sept. 10. Not previously reported on Achillea in Utah.

Puccinia monoica (Pk.) Arth., O, I:

On Arabis microphylla Nutt., on mountain bench east of Logan, Cache Co., May 26. A new host record for this rust.

On Arabis perennans S. Wats., 9 miles north of Monticello, San Juan Co., May 12. A new host record for this rust.

Puccinia pattersoniana Arth., O, I:

On Brodiaea douglasii S. Wats., mouth of Big Cottonwood Canyon near Holladay, Salt Lake Co., May 20.

Puccinia pimpinellae (Str.) Mart., O, I, II, III:

On Osmorrhiza occidentalis Nutt., Logan Canyon, Cache Co., Aug. 6, Sept. 10 and May 27; Ogden Canyon east of Ogden and Snow Basin Recreation Area 8 miles southwest of Huntsville, Weber Co., Sept. 3 and 17; Mt. Timpanogos near Wildwood and Right Fork of Hobble Creek east of Springville, Utah Co., Aug. 20 and Oct. 1. A very common rust.

Puccinia plumbaria Pk., O, I, III:

On Phlox gracilis (Dougl.) Greene (= Microsteris micrantha (Kellogg) Greene), along edge of Ft. Douglas Reservation, Salt Lake City, Salt Lake Co., May 19; on mountain bench east of Logan, May 26, and near mouth of Green Canyon northeast of Logan, June 2, Cache Co.

On Phlox longifolia Nutt., Salt Lake City, May 7 and 19, on bench near Millcreek Canyon and near mouth of Big Cottonwood Canyon near Salt Lake City, May 20, Salt Lake Co. A very common rust, systemic in plants and causing enlargement and thickening of leaves and aborting plants so that they rarely bloom.

Puccinia polygoni-amphibii Pers., II, III:

On Polygonum natans var. hartwrightii (Gray) Sanford, 4 miles west

Puccinia polygoni-amphibii cont.

of Logan, Cache Co., Oct. 22.

Puccinia rubigo-vera agropyri (Erikss.) Arth., I, II, III:

On Agropyron subsecundum Lk., Mt. Timpanogos near Wildwood, Utah Co., Aug. 20.

On Clematis ligusticifolia Nutt., Ogden, Weber Co., Sept. 18.

On Elymus condensatus Presl., 6 miles up Logan Canyon, Cache Co., Sept. 10.

On Elymus glaucus Buckl., Ogden Canyon east of Ogden, Weber Co., Sept. 3.

Puccinia rubigo-vera apocrypta (Ell. & Tr.) Arth., 0, I:

On Hydrophyllum capitatum Dougl., Card Ranger Station in Logan Canyon, June 10, Smithfield Canyon, May 10, and road to Tony Grove Lake from Logan Canyon, June 24, Cache Co.; above Rotary Park in City Creek Canyon near Salt Lake City, Salt Lake Co., June 17.

Puccinia splendens Vize, II, III:

On Hymenoclea salsola Torr. & Gray, 4 miles west of Hurricane, Washington Co., Oct. 31, occurring abundantly and causing fusiform swellings on the older stems. Also collected during the first half of April, 1945, 8 1/2 miles west of Hurricane, between Hurricane and La Verkin, and northeast of La Verkin, Washington Co., Utah, and near Bunkerville and in the Valley of Fire southwest of Overton, Clark Co., Nevada, occurring in great abundance in the last locality. This rust does not appear to have been recorded previously from Nevada and was recorded from Utah only from a single collection made in Washington Co. (Garrett, The Uredinales or Rusts of Utah, Bull. Univ. Utah 28 (7): 44.1937, and in Arthur's Rust Manual) as on H. monogyra Torr. & Gray, a species not recognized as occurring in this State. The host for this rust collection has recently been determined as H. fasiculata A.Nels. by S. F. Blake, who states that this doubtfully distinct species is very close to H. salsola and that many botanists consider them identical.

Puccinia subcircinata Ell. & Ev., III:

On Senecio integerrimus Nutt., Parley's Canyon east of Salt Lake City,

Puccinia subcircinata cont.

Salt Lake Co., May 17; Green Canyon northeast of Logan, May 30, and at the Jardine Juniper near crest of rocky ridge 1 1/2 miles west of junction of Cottonwood and Logan Canyons, June 10, Cache Co.

Puccinia thlaspeos Schub., III:

On Thlaspi glaucum A. Nels., 5 miles up Logan Canyon, Cache Co. Coll. by Mr. Arthur H. Holmgren, June 2, 1944.

Puccinia vagans epilobii-tetragoni DC., III:

On Epilobium paniculatum Nutt., Right Fork of Hobble Creek east of Springville, Utah Co., Oct. 1. Occurring abundantly.

Puccinia violae (Schum.) Arth., II, III:

On Viola adunca J. E. Smith, Right Fork of Hobble Creek east of Springville, Utah Co., Oct. 1.

On Viola nephrophylla Greene, occurring near the preceding. Not reported previously on this host in Utah.

Pucciniastrum pustulatum (Pers.) Diet., II:

On Epilobium adenocaulon Haussk., State Fish Hatchery west of Logan, Cache Co., Oct. 22; South Fork of Ogden River 5 miles east of Huntsville, Weber Co., Sept. 24; Right Fork of Hobble Creek east of Springville, Utah Co., Oct. 1.

Uromyces fabae (Pers.) DBy., III:

On Lathyrus utahensis Jones, 6 miles up Logan Canyon, Cache Co., Oct. 15; Emigration Canyon east of Salt Lake City, Salt Lake Co., Oct. 8.

Uromyces glycyrrhizae (Rab.) Magn., II, III:

On Glycyrrhiza lepidota Nutt., near Cache Junction, Cache Co., Oct.22.

Uromyces intricatus Cke., II, III:

On *Eriogonum loganum* A. Nels., Island in Logan River near Logan, Cache Co. Coll. by B. L. Richards, Oct. 4, 1941. Not reported previously on this host in Utah.

Uromyces junci (Desm.) L. Tul., II, III:

On *Juncus balticus* Willd., State Fish Hatchery west of Logan, Cache Co., Oct. 22. Occurring in great profusion. New to the Utah Flora.

Uromyces striatus medicaginis (Pass.) Arth., II, III:

On *Medicago lupulina* L., La Verkin, Washington Co., Nov. 1. Not previously reported on this host in Utah.

On *Medicago sativa* L., La Verkin, Washington Co., Nov. 1.

Uromyces trifolii fallens (Desm.) Arth., II, III:

On *Trifolium pratense* L., Right Fork of Hobble Creek east of Springville, Utah Co., Oct. 17; La Verkin and Toquerville, Washington Co., Nov. 1 and 2.

USTILAGINALES

Sphacelotheca cruenta (Kühn) Potter:

On *Sorghum halepense* (L.) Pers. (occurring abundantly in orchards). Leeds and Santa Clara, Washington Co., Oct. 30 and 31. New record for the Utah Flora.

Sphacelotheca sorghi (Lk.) Clint.:

On *Sorghum vulgare* Pers., near Springdale, Washington Co. Oct. 29. Occasional in inflorescences of plants in a 1-acre planting.

Ustilago bromivora (Tul.) Fisch. de Waldh.:

On *Bromus rubens* L., occurring in association with *Bromus tectorum* L. attacked by the same smut, Leeds, Washington Co., Oct. 30.

On *Bromus tectorum* L., 7 miles up Logan Canyon, Cache Co., Oct. 1;

Ustilago bromivora cont.

Bountiful, Davis Co., Oct. 6; Mapleton, Columbia Steel Plant south of Provo, and Hobble Creek east of Springville, Utah Co., Sept. 30 and 31 and Oct. 2; Zion Canyon in Zion National Park, Washington Co., Oct. 29. This smut is extremely common and widespread in Utah, frequently infecting high percentages of the plants in areas. Zundel (Mycologia 13: 180. 1921) recorded numerous localities and the percentage of infection in the northeastern part of Utah.

Ustilago hypodytes (Schlecht.) Fr.:

On Distichlis stricta (Torr.) Rydb., at Redmond and Salina, Sevier Co., Oct. 26; also north of Beatty, Nye Co., Nevada, Nov. 4.

On Hilaria jamesii (Torr.) Rydb., La Sal Junction 31 miles north of Monticello, San Juan Co. Coll. by Mr. Arthur H. Holmgren, June 15.

BASIDIOMYCETES

Agaricus arvensis Fr.:

On thick litter of dry duff under Douglas fir (Pseudotsuga taxifolia) on dry mountainside above Pine View Dam in Ogden Canyon, Weber Co., Sept. 3.

Coprinus atramentarius Bull. ex Fr.:

On root of stump of Populus deltoides Bartr., North Logan, Cache Co., May 30.

Crucibulum vulgare Tul.:

On slash of Juniperus scopulorum Sarg., Chokecherry Picnic Ground in Logan Canyon and 1 1/2 miles west of Logan Canyon on Tony Grove Lake Road, Cache Co., June 10 and 24.

Fomes fraxinophilus (Pk.) Sacc. forma ellisianus (F. W. Anderson) Baxter:

On Shepherdia argentea Nutt., Redmond, Sevier Co., Oct. 26; Marysvale Canyon 3 miles north of Marysvale, Bullion Canyon at points 2 and 3 miles west of Marysvale, and 3 and 5 miles northeast of Circleville, Piute Co., Oct. 27 and Apr. 18; at points 2 and 7 miles

Fomes fraxinophilus cont.

south of Panguitch, Garfield Co., Oct. 22 and Apr. 18. Also along the Truckee River at Ramsey Station on the Southern Pacific R. R. 23 miles west of Reno, Storey Co., Nevada, Nov. 9. This fungus occurred in great abundance in local thickets of the host at these points, causing a light brown heart rot and premature death of living stems. It appears to have been reported previously only from Montana, Saskatchewan, South Dakota, Colorado, and New Mexico. Its occurrence in southwestern Utah and western Nevada extends the host range considerably.

Fomes igniarius (L. ex Fr.) Kickx:

On Populus tremuloides Michx., City Creek Canyon near Salt Lake City, Aug. 13; near head of American Fork Canyon and below aspen grove on Mt. Timpanogos, Utah Co., Aug. 20 and May 18; and 15 miles up Logan Canyon and between Logan Canyon and Tony Grove Lake, Cache Co., June 24.

Guepiniopsis alpina (Tr. & Earle) Brasfield:

On decorticated limb of fallen white fir (Abies concolor (Gord. & Glend.) Hoopes, Mt. Timpanogos, Utah Co., May 18.

On decorticated fallen sapling of Abies lasiocarpa (Hook.) Nutt., Tony Grove Lake, Bear River Range, Cache Co., June 24.

On decorticated trunks and limbs of Juniperus scopulorum Sarg., near Jardine Juniper on crest of ridge 1 1/2 miles west of junction of Cottonwood Canyon with Logan Canyon, Cache Co., June 10.

On decorticated limbs of Pseudotsuga taxifolia (Poir.) Britt., same date and locality as the preceding.

Paneolus campanulatus (L.) Quél.:

On stony ground above forks of Logan River in Logan Canyon, Cache Co., June 10.

Pholiota adiposa (Fr.) Quél.:

On Populus deltoides Bartr., fruiting on loose bark over dead area about 12 ft. high on large living tree, Panguitch, Garfield Co., Oct. 27.

Pleurotus ostreatus Jacq. ex Fr.:

On stump of boxelder (Acer negundo L.), Cove, Cache Co., June 3.

On stump and log of narrowleaf cottonwood (Populus angustifolia James), 2/5 mile south of Thistle, Utah Co., May 8; High Creek east of Cove, Cache Co., June 3.

On stumps of eastern cottonwood (Populus deltoides Bartr.), North Logan and Cove, Cache Co., May 30 and June 3. Fruiting abundantly in large masses.

On stumps of Lombardy poplar (Populus nigra var. italica Muensch.), North Logan and Cove, Cache Co., May 30 and June 3.

Polyporus abietinus Dicks. ex Fr.:

On fallen trunks of Abies concolor (Gord. & Glend.) Hoopes, Big Tree Camp Ground on flank of Mt. Timpanogos, Utah Co., May 18; 1 mile above Rotary Park in City Creek Canyon near Salt Lake City, Salt Lake Co., June 17.

On fallen trunk of Abies lasiocarpa (Hook.) Nutt., 1 1/2 miles west of Logan Canyon on Tony Grove Lake Road, Cache Co., June 24.

On fallen trunk of Pseudotsuga taxifolia (Poir.) Britt., crest of ridge 1 1/2 miles west of junction of Cottonwood and Logan Canyons, Cache Co., June 10.

Polyporus adustus Willd. ex Fr.:

On charred stump of Populus fremonti S. Wats., 2 1/2 miles southeast of Price, Carbon Co., May 8.

Polyporus alboluteus Ell. & Ev.:

On decorticated fallen trunks of Picea engelmanni Parry, Tony Grove Lake, Bear River Range, Cache Co., June 24.

Polyporus hirsutus Wulf. ex Fr.:

On sweet cherry (Prunus avium L.) as wound parasite on limb of living tree, North Ogden, Weber Co., Sept. 14. This fungus is considered by Dr. B. L. Richards to be a rather frequent cause of

Polyporus hirsutus cont.

decay and trunk splitting of orchard trees in Utah.

On fallen trunk of Betula fontinalis Sarg., 1 mile above Rotary Park in City Creek Canyon near Salt Lake City, Salt Lake Co., June 17.

Polyporus leucospongia Cke. & Harkn.:

On fallen decorticated trunks of Abies lasiocarpa (Hook.) Nutt., Tony Grove Lake, Bear River Range, Cache Co., June 24.

On fallen decorticated trunks of Picea engelmanni Parry. Same locality and date as the preceding.

On branches of fallen Pinus ponderosa var. scopulorum Engelm., La Sal National Park at points 27 and 31 miles west of Blanding, San Juan Co., May 15.

Polyporus munzii Lloyd:

Large imbricate mass of sporophores at base of dead tree of Populus fremonti S. Wats., St. George, Washington Co., Apr. 15. According to Dr. L. O. Overholts this was previously known only from Arizona and California.

Polyporus submaculatus Murr.:

On decorticated fallen sapling of Populus tremuloides Michx. on mountainside above Pine View Dam in Ogden Canyon, Weber Co., Sept. 3. This was described as a new species by Dr. W. A. Murrill (Mycologia 37 (1): 157. 1945).

Polyporus volvatus Pk.:

On recently dead alpine fir (Abies lasiocarpa (Hook.) Nutt., 1 1/2 miles west of Logan Canyon on Tony Grove Lake Road, Bear River Range, Cache Co., June 24.

Stropharia melanosperma (Bull.) P. Karst.:

On stony ground along lower portion of Jardine Juniper Trail from Cottonwood branch of Logan Canyon, Cache Co., June 10.

Trametes hispida Pass.:

On dead limbs and logs of Populus angustifolia James, Smithfield Canyon and High Creek east of Cove, Cache Co., Apr. 29 and June 3; on flank of Mt. Timpanogos, Utah Co., May 18.

On dead limbs of sweet cherry (Prunus avium L.) tree in orchard; also on hardwood fence post brace, Hurricane, Washington Co., Nov. 1.

FUNGI IMPERFECTI

Cryptosporium sp.:

On Tetradymia glabrata A. Gray, 20 miles north of Beatty, Nye Co., Nevada, Nov. 4. This fungus, which does not appear to be described, commonly forms abundant minute pycnidia on the leaves. It was later observed at other points in Nevada and appears to be widespread.

Cylindrosporium lutescens Higgins:

On Prunus virginiana var. demissa (Nutt.) Torr., Ogden Canyon east of Ogden, Weber Co., Sept. 3. Collections of this fungus by Dr. B. L. Richards from Tony Grove Lake and Smithfield Canyon, Cache Co., June, 1940, and Sept. 1, 1941, also have been examined. It is said by him to be very common.

Gloeosporium nervisequum (Fckl.) Sacc.:

On Platanus occidentalis L., causing considerable injury to street trees at American Fork, Utah Co., June 16. Dr. B. L. Richards reports this disease as widespread throughout northern Utah wherever American sycamore is planted. The oriental sycamore does not appear to be attacked.

Monilinia demissa (Dana) Honey:

On Prunus virginiana var. demissa (Nutt.) Torr., lower portion of Jardine Juniper Trail from Cottonwood Canyon, Cache Co., June 10. Reported by Dr. B. L. Richards to be a rather common cause of dying back of shoots.

Ovularia obliqua (Cke.) Oud.:

On Rumex crispus L., near Cache Junction, Cache Co., Oct. 22; La Verkin, Washington Co., Nov. 1.

Phyllosticta cacti (Berk.) Archer:

On dead stems of Opuntia acanthocarpa (Engelm.) Bigel., 5.3 miles on road from St. George to Veyo, Washington Co., Apr. 15. Associated with Teichospora mammoides Ell. & Ev.

Phyllosticta clematidis Ell. & Dearn.:

On Clematis douglasii Hook., Mt. Naomi region, Bear River Range, Cache Co. Coll. by Dr. B. L. Richards, Sept. 5, 1941.

Phyllosticta minutissima Ell. & Ev.:

See under Septoria aceris (Lib.) Berk. & Br.

Phyllosticta virginiana (Ell. & Halst.) Seav.:

On Prunus virginiana var. demissa (Nutt.) Torr., South Fork of Ogden River 7 miles east of Huntsville, Weber Co., Sept. 24. A collection of this fungus by Dr. B. L. Richards in Logan Canyon, Cache Co. also has been examined.

Septoria aceris (Lib.) Berk. & Br.:

On Acer glabrum Torr., Smithfield Canyon, Cache Co. Coll. by Dr. B. L. Richards, Sept. 1, 1941; City Creek Canyon near Salt Lake City, Salt Lake Co., Aug. 13; Ogden Canyon east of Ogden, Weber Co., Sept. 1; Timpanogos Cave in American Fork Canyon, Utah Co., Aug. 20. Causing abundant leaf-spotting, yellowing and premature defoliation.

On Acer grandidentatum Nutt., Ogden Canyon east of Ogden, Weber Co., Sept. 3.

On Acer negundo L., Island in Logan River near Logan, Cache Co. Coll. by Dr. B. L. Richards, Oct. 4, 1941; Ogden Canyon east of Ogden and at Ogden, Weber Co., Aug. 20 and Sept. 3; City Creek Canyon east of Salt Lake City, Salt Lake Co., Aug. 3; Timpanogos Cave in

Septoria aceris cont.

American Fork Canyon and at Mapleton, Utah Co., Aug. 20 and 21. This fungus is extremely common and widespread on both this species and *A. glabrum*. *Phyllosticta minutissima* Ell. & Ev. was associated with it in all the collections enumerated, and on *A. glabrum* this fungus usually was much more abundant than the *Septoria*. Gilman and Archer (The fungi of Iowa parasitic on plants, p. 418 . 1929) regard this fungus as a microspore stage of *Septoria aceris* and consider it synonymous.

Septoria aurea var. *destruens* Ell. & Ev.:

On *Ribes aureum* Pursh, Ogden Canyon east of Ogden, Weber Co., Sept. 3. Causing a leaf spot.

Septoria symphoricarpi Ell. & Ev.:

On *Symphoricarpos vaccinioides* Rydb., 15 1/2 miles up Logan Canyon, Cache Co., June 24.

Tubercularia vulgaris Tode:

On *Prunus virginiana* var. *demissa* (Nutt.) Torr., Smithfield Canyon, Cache Co., Apr. 29. On dead twigs and branches mostly killed by black knot.

PLANT DISEASE REPORTER SUPPLEMENT

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ROOTROTS AND LEAFSPOTS OF GRAINS AND GRASSES IN THE NORTHERN GREAT PLAINS AND WESTERN STATES[1]

Roderick Sprague[2]

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INTRODUCTION

As delimited by the title, this annotated list contains at least mention of all the parasites known by the writer to attack Gramineae in the western United States. Since he has experienced difficulty in staying abreast of the literature on these some 200 species of fungi on nearly 500 hosts, the writer has assembled this material primarily for his own use. While the resulting preliminary work is not a text, it is somewhat more than a list and it seems that it may have some value to a number of western experiment station workers and field men in the routine diagnosis and study of the lesser known leafspot and rootrot diseases of grasses and cereals. Since brevity has been necessary it appeared to the writer that some of the better known parasites

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1 Cooperative investigations between the Divisions of Cereal Crops and Diseases, Forage Crops and Diseases, and Soils, Fertilizers, and Irrigation, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration; and the Division of Nurseries, Soil Conservation Service, U. S. Department of Agriculture; and the North Dakota Agricultural Experiment Station.

2 Pathologist, Division of Cereal Crops and Diseases, and Collaborator, Division of Forage Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Mandan, N. Dakota.

could be given less space than some of the lesser known ones, as information on the latter frequently is buried in obscure journals. Most of the important diseases of cereals have been well covered in such standard texts as Heald's Manual (316)[3], Owens (497), Chester (103), and Dickson (160). This article, then, may be useful as a supplement to available texts.

This outline is the result of work started about 15 years ago at Corvallis, Oregon, and is partly a direct outgrowth of several check lists issued in 1935, 1937, and 1942. The writer felt that the regrassing program, started during and after the dry years of the last decade, would eventually require more information on the fungi of Gramineae than was then available. There were others soon interested in studying this neglected field. The recent and current work, for instance, of Fischer on fundamental taxonomy of the smuts of grasses has added a great deal of needed data on this group. Research in the Canadian provinces on rootrots, the studies made at Iowa State College on Pythium spp., and the publication of such texts as Grove (296, 297) and Sampson and Western (572) have aided workers during recent years. There is a new publication by Garrett (257), which gives a modern and understandable summary of the epidemiology of rootrots in general. The recent text by Gilman (262) is also helpful in determining common soil molds associated with parasitic root fungi, as are texts by Thom (705), Jensen (362), Boedijn (55), and Clements and Shear (117), and the Checklist by Weiss (755-757).

The region covered herein is by no means thoroughly explored from our viewpoint. However, during the past decade various workers have collected and studied intensively in widely scattered parts of it. Probably the greatest impetus to this work has been the increase in knowledge of the hosts through the publication of Hitchcock's manual of the grasses (326) and the increase in the number of workers who are able to determine the hosts with a fair degree of accuracy. We therefore find that the western part of the United States is, in general, as well covered as the eastern part. Seymour (599) contains about 2,820 citations (hosts x fungi) of parasitic fungi for all of North America on Gramineae, while the unpublished list of the writer and Fischer includes 3257 citations for the western area alone. Since Seymour's list appears to contain very few western citations other than rusts and smuts it is apparent that the recent investigations have greatly expanded the host range on Gramineae in this once neglected region.

This article includes reference to about 221 species and sub-divisions of species of parasitic fungi found growing naturally in the region. There are 13 Phycomycetes, 24 Ascomycetes (if we include 15 species of Phyllachora), 8 Basidiomycetes, and 162 Fungi Imperfecti, as well as a few undetermined or non-parasitic troubles. In addition, brief mention

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[3] Figures in parentheses refer to "Literature cited," p. 215.

is made of associated non-parasitic saprophytes which are sometimes such early invaders of dead tissue that they have been considered as weakly parasitic in some cases. The following table indicates the number of species of leafspot and rootrot-causing fungi reported on Gramineae in the several western States.

Number of species found in:	Class of fungi					
	Phyco-mycetes	Asco-mycetes	Basidio-mycetes	Fungi Imperfecti	Miscellany	Total
North Dakota	8	11	3	79	4	105
South Dakota	7	9	1	49	0	66
Minnesota	6	7	4	43	2	62
Iowa	7	7	2	35	1	52
Nebraska	5	10	1	42	0	58
New Mexico	1	9	0	7	0	17
Arizona	1	5	0	5	2	13
Colorado	1	5	0	13	1	20
Utah	0	3	2	10	1	16
Wyoming	2	3	2	40	0	47
Montana	8	5	4	45	0	62
Idaho	0	4	3	30	2	39
Washington	5	6	4	67	2	84
Oregon	6	7	4	97	1	115
California	3	9	1	47	3	63
Nevada	0	0	0	1	0	1
Alaska	0	1	0	5	0	6

It is evident from the table that Oregon, North Dakota, and Washington have been the most thoroughly explored. Some States such as Nevada have very few fungi reported on Gramineae other than rusts and smuts. Of course climate influences these records tremendously. The coast region of Oregon, Washington, and northern California is highly favorable to the development of leafspot fungi while some of the Rocky Mountain areas also harbor a large number of them. The arid plains have few leaf spots but many rootrot fungi and late-summer leaf spots occur in the Northern Great Plains. The wooded and swamp areas of Minnesota contain numerous leaf spots.

An intensive survey has been conducted in Washington and North Dakota on exotic hosts in the large grass nurseries at Pullman and Mandan. Therefore the greatest host range (fungi x hosts) occurs in North Dakota with 1,369 citations to all fungi including smuts and rusts. Washington has 971 citations, Oregon has 912 (mostly on native species), South Dakota 497, Montana 460, Minnesota 445, California 437, Nebraska 331, Iowa 327, Wyoming 282, Colorado 264 (mostly rusts and smuts), Idaho 262, Utah 152, New Mexico 133, Arizona 133, Alaska 40, and Nevada 39. This indicates approximately which States need additional survey information.

While the majority of the cereal diseases are well covered in plant pathological literature, many of the fungi causing grass diseases are scarcely mentioned except for the original mycological description. Therefore it is still necessary for workers with these fungi to be acquainted with the location of these descriptions as well as where the type material or comparable exsiccati may be found. Material available from the western area is not plentiful among the earlier collections. David Griffith's Western American Fungi contains numerous smut fungi but few of the fungi that fall within the bounds of this study. Brenckle's Fungi Dakotensis, Ellis and Everhart's and associates' various collections, and Cooke's recent Mycobiota series contain some collections, while Solheim's Mycoflora Saximontanensis is also useful. Most of the material dealt with by the writer is filed either at Oregon State College, Corvallis, Oregon; or is in the Mycological Collections of the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture, Beltsville, Maryland. Some of this material is scanty and of use for record only, but an attempt was made to preserve a fairly complete record of recent collections.

In this article, the fungi are listed alphabetically under the classes: (1) Phycomycetes, page 105, (2) Ascomycetes, page 111, (3) Basidiomycetes, page 116, and (4) Fungi Imperfecti, page 120. No attempt has been made to give an exhaustive list of references, but instead only those are included that are considered necessary for a working basis. It has not been possible to check all references against the originals and therefore considerable use has been made of abstract journals.

In discussing the various fungi, usually brief summaries are given of

symptoms, host range, and sometimes morphology; and less often of taxonomy.

PHYCOMYCETES

APHANOMYCES SPP. Root Necrosis.

Pure cultures of Aphanomyces have been isolated from oats growing in acid soil in northern Minnesota, eastern Montana, and in the coast region of Oregon. Scattered isolates have also been obtained from meadow fescue (Festuca elatior L.), red fescue (F. rubra L.), and green needle grass (Stipa viridula Trin.) from Mandan, North Dakota, and from Setaria viridis (L.) Beauv. mingled with oats in eastern Montana. The only place where there was very much evidence of damage was in the very red, very acid soil in Lincoln County, Oregon, and even in this instance the fungus was associated with so many other organisms that its exact role was not readily determinable (Sprague, 639). The culture from northern Minnesota appears to be A. camptostylus Drechs., which is a somewhat delicate-appearing fungus originally isolated from diseased oat roots at Sauk City, Wisconsin, by M. B. Linford. The writer worked with this fungus in 1926 at Madison and has found that some of his recent isolates were similar in appearance. No study has been made with these forms in North Dakota as yet, because they appear to be less important than a number of other fungi. However, as species of Aphanomyces are somewhat difficult to isolate, they may be more prevalent than our occasional isolates would indicate. They are evidently of more importance in northern Minnesota and in the coast region in Oregon.

References: Drechsler (181, figs. 9-11); Sprague (639).

PHYTOPHTHORA SPP., Rot.

Phytophthora cactorum (Leb. and Cohn) Schroet. and some undetermined forms are sometimes found associated with soft rots of the leaves and roots of grains and grasses. While corn is the most frequently reported host (Sideris, 606), the following have been noted: quack grass (Minnesota), Triticum durum Desf., Agropyron sibiricum (Willd.) Beauv., Hordeum jubatum L., and Stipa viridula Trin. in North Dakota, Lolium multiflorum Lam. (Oregon), Poa vaseyochloa Scribn. (Oregon), and Avena fatua L. (Oregon and California). This fungus needs abundant moisture to be able to develop parasitically.

McMurphy (450) noted a species similar to Phytophthora calocasiae Rac. (Tucker, 716) on oats in California. The infected areas were at first yellowish, then whitish, and finally brown or reddish brown. The fragmentary material seen by the writer on wild oats (Avena fatua) near The Dalles, Oregon, and in northern coastal California were only

water-soaked leaves in contact with the soil. The North Dakota isolations were from roots of seedlings and were usually associated with other fungi. The most abundant material that the writer has obtained was in stunted plants of barnyard grass growing near Belle Fourche, South Dakota. This material appeared to be P. cactorum. A similar fungus was isolated from corn roots near Newell, South Dakota, at the same time. In the greenhouse at Mandan artificial inoculations with this fungus (inoculum added to soil at seeding time) caused 88 percent loss in Turghai proso, only 6 percent loss in crested wheatgrass, scarcely a trace in wheat, 70 percent in Ladak alfalfa, 71 percent in blue grama, and only a trace in corn. Its injury was confined to seed rot at the temperature employed (48° to 70° F). In general, Phytophthora is not important on Gramineae.

References: McMurphy (450); Sideris (606); Tucker (716, 717).

(?) SYNCHYTRIUM SP., Purple Leaf Speckle.

In 1942, the writer (656) stated that this fungus was a "primitive unilocular body or cluster of large cells imbedded in a leaf spot." There is no appreciable gall formation and for that reason it was doubted that the fungus was a species of Synchytrium. It appeared to be nearest to Eurychasmidium (Karling, 377) of the Ectrogellaceae. However, recent illustrations by Cook (124) of species of Synchytrium from Louisiana more strongly suggest that this fungus could be placed in Synchytrium. We have not been able to find mention of a similar fungus on grass unless it be the somewhat vague Protomyces rhizobius Trail, which occurs on Poa annua L. in Scotland. There is, however, little or no mycelium present in the material from Oregon and Washington. Protomyces is placed in either the Phycomycetes or the Ascomycetes, depending on the authority.

In Oregon and Washington, the fungus is relatively common but seldom destructive during open, wet, winter weather in the Willamette Valley of Oregon, and the coastal region of both States. It is sometimes found on bent grass lawns at Corvallis. It occurs on Agrostis alba L., A. canina L., A. exarata Trin., A. hallii Vasey, A. palustris Huds., A. tenuis Sibth., Anthoxanthum odoratum L., Bromus carinatus Hook. and Arn., Dactylis glomerata L., Elymus glaucus Buckl., Festuca rubra var. commutata Gaud., Poa annua L., P. juncifolia Scribn., P. pratensis L., and P. secunda Presl. Representative material is filed at Oregon State College and at Harvard University.

References: Cook (124); Karling (377); Sprague (655, 656).

PYTHIUM ARISTOSPORUM Vanterpool
Root Browning of Grains, Seedling Blight of Grasses.

This fungus is closely related to the much more abundant *Pythium arrhenomanes* Drechs. In the United States it has been isolated from wheat, crested wheatgrass (*Agropyron cristatum* (L.) Gaertn.), orchard grass (*Dactylis glomerata* L.), barnyard grass (*Echinochloa crusgalli* (L.) Beauv.), and tall meadow oatgrass (*Arrhenatherum elatius* (L.) Beauv.) at Bozeman, Montana, on barley at Dickinson, North Dakota, and on this host and oats near Eugene, Oregon, and on slender wheatgrass (*Agropyron trachycaulum* (Lk.) Malte) at Mandan, North Dakota. Like *P. arrhenomanes* this species produces a wet-appearing pebbly growth on potato-dextrose agar, but the oogonia with their numerous antheridia do not disintegrate quite as fast as do those of *P. arrhenomanes*. The oogonia also appear to be larger in *P. aristosporum*.

References: Sleeth (614); Vanterpool (739, Fig. 2, Pl. XXII; 743); Vanterpool and Sprague (744).

PYTHIUM ARRHENOMANES Drechs.
Root Browning of Grains, Seedling Blight of Grasses.

Root browning is characterized by dark brown lesions on the small roots of small grains (wheat, oats, barley) in late May and June in the Northern Great Plains and adjacent regions. The plants when severely infected show a pale green color in contrast with healthy ones. This fungus is very widespread in all of the northern plains States and also causes a serious seedling blight of sorghum in the Sacramento Delta region of California. It is the well-known cause of Milo disease in the Great Plains. The most serious aspect of this fungus is its effect on spring-seeded grasses in North Dakota, South Dakota, Nebraska, and Minnesota. It causes a blight of the young plants, which wither and die about 6 weeks after seeding. During some years, almost 100 percent kills have occurred in crested wheatgrass, slender wheatgrass, and smooth brome (*Bromus inermis* Leyss.) at Brookings, South Dakota, and in places in North Dakota. The host range is very great (Vanterpool and Sprague 744). Curzi (134) reports a similar disease on cereals in Italy but the identity of the Italian fungus has not yet been determined.

Drechsler (185) contends that his *Pythium arrhenomanes* (179) is distinct from *P. graminicolum* Subr. (692) because, "the close mycelial connection between oogonium and antheridium, very frequent in *P. graminicolum*, is rare in *P. arrhenomanes*; and in parallel cultures the sturdy, more substantial membranous parts of the sexual apparatus of the former species remain clearly discernible long after the evanescent antheridial envelopes and supporting branches of the latter have become nearly or wholly invisible." On the basis of this distinction the material in the Northern Great Plains is *P. arrhenomanes*, except *P. aristosporum* which has the long-lived traits of *P. graminicolum* in

pure culture. Both P. arrhenomanes and P. graminicolum are recognized by Matthews (440).

Root browning in Saskatchewan (Vanterpool, 740, 742) is partly checked by judicious use of phosphate fertilizers wherein a proper balance of nitrogen is maintained. Hanson (306) has obtained striking results in the control of rootrot at Lamberton, Minnesota, by the use of phosphate or phosphate and nitrogen fertilizers on wheat. The writer obtained similar results in the coast region of Oregon, but in the Northern Great Plains where most areas are not yet deficient in phosphorus and where nitrogen is not seriously deficient, fertilizing has not had much effect on root browning, except that recent trials with ammonium phosphate (16-20-0) indicate that this material may have some effect on the parasite as well as on the host. Partial control of the rootrot complex in wheat with 100 lbs. of ammonium phosphate per acre in trials at McCanna, North Dakota, have shown particular promise (Sprague, annual report, 1945).

Since Pythium arrhenomanes is restricted to Gramineae, use of nongrass plants in rotation reduces its injury. Among cereals oats are most tolerant; proso millets (Panicum miliaceum) or sorghums usually are less desirable to grow. While fallow does not appear to increase the amount of Pythium it creates the same effect by starving out other organisms, permitting the Pythium forms temporary ascendancy. Small-seeded grasses should not be seeded on fallow if it can be avoided, at least not in the spring of the year. Crested wheat grass, whoever, can be sown on fallow under most conditions. Fall seeding is preferred to spring seeding where conditions permit. Even winter seeding of crested wheatgrass is preferred if periods of open weather occur as is sometimes the case in North Dakota.

References: Andrews (14); Bowman et al. (61); Branstetter (63) Buchholtz (78); Carpenter (92); Conners and Savile (123); Curzi (134); Drechsler (179, 185); Edgerton, Tims, and Mills (194); Elliott et al. (204, figs. 1-8, 17, 21); Flor (232); Hanson (306); Ho and Melhus (330); Ho et al. (331); Ho and Koepper (329); Hoffmaster (333); Johann (364); Kendrick and Briggs (380); Leukel (403, fig. 1); Matthews (440); Melchers (455); Melchers and Lowe (456, 457); Melhus, Martin, and Murphy (460); Middleton (465); Rands and Dopp (523, 524, 525); Roldan (539, 540); Sallans (567); Simmonds, Russell, and Sallans (611); Sprague (658, 661, 663); Sprague and Atkinson (670); Subramaniam (692); Vanterpool (737, 738, 739, 740, 741, 742, 743); Vanterpool and Sprague (744); Vanterpool and Truscott (745); Wagner (749).

PYTHIUM DEBARYANUM Hesse, P. IRREGULARE Buis., P. ULTIMUM Trow
Seed rot, Damping-off and Root Necrosis.

Although two of the originally recognized hosts of P. debaryanum were Panicum miliaceum L. (proso millet) and Zea mays L. (Hesse, 325), this fungus is little recognized as a parasite of Gramineae. However, Eriksson (219) and also Gram and Rostrup (281) report it on barley, and there are a number of citations on cane crops, including corn, (Ho, 328). In the Northern Great Plains, P. debaryanum and related species cause considerable seed rot in wet soil in the spring and may cause damping-off or seedling injury to some small-seeded grasses (Sprague, 665). Sometimes when cereals are planted in low wet ground or when old moldy seed is planted in heavy ground Pythium will cause seed rot. The injury in most cases in both grasses and cereals occurs just as the seed sprouts. The rootlets are unable to emerge. In the greenhouse under artificial conditions some grasses have the roots reduced to yellow or brown stubs even after emergence. There are various strains of these fungi that will attack some hosts more readily than others. Some will attack certain cereals, such as wheat, barley, and oats, more severely than others; some strains from grasses will attack many species of grasses but are mildly parasitic on non-grass crops; while in other cases the reverse is true. In general, however, the host range is so great that crop rotation to control this group would be very difficult to work out. Since legumes, notably alfalfa, are very susceptible to P. debaryanum (Buchholtz, 79) and fallow seems to favor it, the control of P. debaryanum becomes even more difficult than that of P. arrhenomanes, which is confined to the grass family. However, P. debaryanum is usually not an important parasite on wheat and usually does not cause the complete destruction on grasses that seedling blight (P. arrhenomanes) does. Buchholtz (78) has shown that seedling blight symptoms are produced by P. arrhenomanes (called P. graminicolum by him). We have found that recovery from P. debaryanum is very rapid and from P. arrhenomanes very slow, in many grasses, in the recovery period after the June seedling blight days have passed. P. debaryanum is, therefore, mainly important as a seed rot but can cause some root necrosis. Oats are somewhat more susceptible to P. debaryanum, especially during cool, wet weather (Welch, 758; Gram and Rostrup, 281; Beaumont, 29).

Pythium debaryanum, P. ultimum, and P. irregulare belong to the sphaerosporangial group of Pythium spp., that is the sporangia are spherical or lemon-shaped. On the other hand, P. aristosporum and P. arrhenomanes produce irregular, lobed or lobulate swollen bodies, from which stalked spherical sporangia develop later. P. debaryanum is by far the most common of the sphaerosporangial forms on Gramineae in North Dakota. P. ultimum is common in the Palouse region near Pullman, Washington, in the heavy Palouse silt loam in early season. P. irregulare is scattered but not uncommon on oats and brome grasses (B. inermis, B. tectorum L.). It is distinguished from the other two by its irregular oogonial wall with prominent projections. P. debaryanum produces zoospores from the sporangia, but P. ultimum germinates

direct by sending out germ tubes from the sporangia. In addition, in P. ultimum the antheridia arise from the oogonial stalk while in P. debaryanum the several antheridia are likely to be produced from distinct, distant hyphae. P. vexans DBy. is another sphaerosporangial species sometimes encountered on grasses and cereals, more or less readily distinguished by its broadly appressed antheridial attachment. Also, P. hypogynum Middleton (464) probably occurs in North Dakota on wheat (Sprague isolation notes). This fungus has the antheridium growing up through the oogonial stalk. Still another related species, P. iwayamai Ito (Ito and Tokunaga 355), was said to cause a snow rot disease of cereals in Japan (Iwayama, 356), but this has not been seen in the United States. Biraghi (48) reported P. polymorphon Sideris (606), which may be the same as P. irregulare, on wheat from Italy.

References: Beaumont (29); Biraghi (48); Buchholtz (78, 79); Butler (87); Drechsler (178); Eddins (192); Eriksson (219); Gram and Rostrup (281); Grandfield, Lefebvre, and Metzger (282); Hesse (325); Ho (328); Ho and Melhus (330); Höhnk (335); Ito and Tokunaga (355); Iwayama (356); Matthews (440, pl. 17, fig. 17-21,22,24,25); McLaughlin et al. (449); Melhus et al. (461); Meredith (462, 463); Middleton (464, 465); Miura (471); Petri (513); Ramakrishan (522); Sideris (606); Sprague (658, 663, 664); Spyshneva (677, 678); Van Luijk (736); Vanterpool (743); Welch (758, 759).

PYTHIUM MONOSPERMUM Pringsh., Root Necrosis.
(P. complens A. Fischer)

Pythium monospermum was isolated from mildly necrotic roots of Turghai proso millet at Mandan, North Dakota, and from Sporobolus cryptandrus (Torr.) A. Gray near Buffalo, South Dakota. It has filamentous or semi-lobulate branched sporangia. An inoculation trial at Mandan with the Mandan isolate caused 62 percent loss in crested wheatgrass, 100 percent loss in alfalfa and blue grama (Bouteloua gracilis (H.B.K.) Lag.) 31 percent in wheat, 28 percent in oats, and only 4 percent in corn. It should be added that Drechsler (177) could not infect cabbage heads with P. monospermum, but with the culture at Mandan, 98 percent pre-emergence seedling kill was obtained in Chinese cabbage and 100 percent in tomatoes. P. monospermum appears to be rare in the Northern Great Plains.

References: Drechsler (177); Matthews (440); Middleton (465).

PYTHIUM PERIILUM Drechs., Root Necrosis.

What appears to be Pythium periilum was isolated from the roots of quack grass (Agropyron repens (L.) Beauv.) in a gray, glacial soil near Bemidji, Minnesota. The oogonia were similar to those illustrated by

Drechsler in one of his remarkable drawings (186, fig. 5). The culture from the Bemidji material died before its pathogenicity could be tested. Stevenson and Rands (685) and Rands and Dopp (524) stated that it was feebly parasitic on sugar cane roots. Further study is needed with this Minnesota form.

References: Drechsler (183, 186); Rands and Dopp (524); Stevenson and Rands (685).

PYTHIUM ROSTRATUM Butl., Root Necrosis.

Pythium rostratum was isolated in May 1942 from roots of Avena sativa L. at Pullman, Washington. It is generally considered to be a soil saprophyte and no data is available on whether it is parasitic on oats. It was associated with mild root necrosis.

References: Butler (86); Matthews (440, pl. 17); Middleton (465).

PYTHIUM TARDICRESCENS Vanterpool, Root Browning.

Vanterpool found Pythium tardicrescens moderately common in Saskatchewan, Canada, but it has been found only twice in the United States, once on Avena fatua L. at Pullman, Washington, and once on barnyard grass at Graceton, Minnesota. It produces a firm, dark brown rot or root browning, and in our trials has about the same host range and relative pathogenicity as the other lobulate sporangial species such as P. arrhenomanes. The oogonia generally average smaller than P. arrhenomanes and have a characteristic sub-globulate content. The fungus produces a weak scanty growth in culture on corn-meal agar and only a few oogonia mature.

References: Sprague (658; 663); Vanterpool (739, fig. 1, pl. XXI; 740; 743).

ASCOMYCETES

DOTHICHLOË LIMITATA Diehl, Leaf Disease.
(D. atramentosa (Berk. and Curt.) Atk.)

Diehl (170) described Dothichloë limitata as having white conidial masses on the upper leaf surfaces of infected leaves. While the fungus is largely found in warm temperate areas, it ranges as far north as North Dakota where it occurs on Calamagrostis inexpansa A. Gray. Diehl believes that this fungus is systemic and that it causes sterility in

the grasses it attacks. Low temperatures inhibit its fructification and no doubt limit its northward distribution.

References: Chardon (102, pl. 14, fig. 12); Diehl (168, pl. 2, D, E, and fig. 3, B; 170, pl. 1).

DOTHIDELLA ARISTIDAE (Schw.) Ell. and Ev.
(See Septogloeum oxysporum Sacc., Bomm. and Rouss. in the Fungi Imperfecti, p. 170).

EPICHLOË TYPHINA (Fr.) Tul., Cat-tail Disease or Choke.

Epichloë typhina forms a cylindrical collar of creamy, later dark orange stroma around the culms of various grasses, causing some sterility. In North Dakota it has been found on Canada bluegrass (Poa compressa L.), Kentucky bluegrass (P. pratensis), Sandberg bluegrass (P. secunda), western wheatgrass (Agropyron smithii Rydb.), slender wheatgrass (A. trachycaulum), Virginia wild-rye (Elymus virginicus L.) and Junegrass (Koeleria cristata (L.) Pers.). At Pullman, Washington, it is found on Agropyron spicatum (Pursh) Scribn. and Sm., A. trachycaulum, Elymus canadensis L., E. dahuricus Turcz., and Poa stenantha Trin. It occurs also at Whitehall, Montana, on Agropyron smithii. It occurs on timothy and Kentucky bluegrass in Nebraska, on slender wheatgrass in Montana, on Junegrass in South Dakota, on A. inerme (Scribn. and Sm.) Rydb. at Athol, Idaho, and on Hystrix patula Moench in Minnesota. It is more spectacular than important in most cases.

References: Sampson (568, 569); Stevens (682).

GIBBERELLA ZEAE (Schw.) Petch. See Fusarium graminearum, Schw. p. 181.

LEPTOSPHAERIA HERPOTRICHOIDES De N., Secondary Rootrot.

Leptosphaeria herpotrichoides was, for many years, believed to be the main cause of straw-breaker footrot of cereals, especially wheat, in Europe. Research has shown that it is actually only a questionable, weak parasite (Sprague, 620; 622; Sprague and Fellows, 671) and it is seldom mentioned in recent literature, Cercosporella herpotrichoides Fron having replaced it as the recognized cause of the straw-breaker disease in Europe and the Pacific Northwest.

Leptosphaeria herpotrichoides was found by the writer on dead culms of rye near Leonard, North Dakota, in 1940 and was reported on wheat from Peone Prairie, Washington, by McKinney (446, p. 29).

References: Delacroix (147); Henry and Foster (324); Mangin (432); McKinney (446); Sprague (620, 622); Sprague and Fellows (671).

MYCOSPHAERELLA TULASNEI (Jancz.) Rothers, Leaf Mold
(Cladosporium herbarum Lk.)

The conidial stage (Cladosporium herbarum) is an omnipresent saprophyte. There are some indications that in early spring it is parasitic on the leaves of certain grasses, notably western wheatgrass at Mandan and Idaho fescue (Festuca idahoensis Elmer) in the far west. It produces brown flecks on the young leaves and forms a brown to olive-black mold on any of the above-ground parts after the plant dies. There is some doubt about whether it is parasitic on the young leaves of western wheatgrass at Mandan, North Dakota, because it usually follows early spring low-temperature conditions. In addition to the early season condition, it is often associated with leaf rusts and with such leaf parasites as Septoria nodorum Berk. It is seldom isolated from the roots of cereals and grasses.

The conidiophores of this species form dense tufts of velvety olive-black color. The conidiophores are more or less erect, septate, sparsely branched; spores often in chains of 2 or 3, sub-cylindric, pale olive, 1-(2-3) septate, 10-15 x 4-7 μ. Heald and Ruehle (317) presented evidence that the microsporous stage, Hormodendrum cladosporioides Sacc., is not conclusively part of the cycle of M. tulasnei. They verified (Ruehle 547, Heald and Ruehle, 317) the work of Janczewski (360) who determined that M. tulasnei was the perithecial stage of C. herbarum. The writer obtained M. tulasnei in a pure culture of C. herbarum in 1943, isolated from Stipa viridula in western North Dakota.

Ruehle in his work with fruit rots (547) reported the perithecia of Mycosphaerella tulasnei as black with thick walls, typically broadly flask-shaped with a short neck, erumpent, 150-250 x 100-150 μ; asci cylindrical, fusoid or slightly tapering at the ends, 80-120 x 15-20 μ; ascospores oblong, bluntly pointed, 1-septate, upper cell somewhat larger than the lower one, 18-28 x 6- 8.5 μ.

Cladosporium herbarum is probably one of several species of this genus on Gramineae, but without sufficient critical modern study, the writer follows precedent in assigning them all to C. herbarum. C. graminum Cda. is frequently used also. Its distinction from C. herbarum is not clear. Schnellhardt and Heald (586) report C. malorum Ruehle as common on wheat seeds in Washington.

Cladosporium herbarum is probably not important in its role as mold on shocked or standing grain but seed treatment with New Improved Ceresan is recommended, as its presence often indicates occurrence of more virulent forms also.

Mycosphaerella tassiana (De N.) Johans. has been found on grasses in the far west but it is evidently not related to the C. herbarum complex. Cash (97) listed M. longissima Fckl. on Bromus secalinus L. from Sitka, Alaska.

References: Bennett (31); Bockmann (54); Cash (97); Heald and Ruehle (317, fig. 9; 13, O, P, Q); Janczewski (360); Ruehle (546, 547); Schnellhardt and Heald (586).

OPHIOBOLUS GRAMINIS Sacc., Take-all.

In the region covered by this paper, take-all occurs in Oregon, Washington, Idaho, and northern California. During the historically open winter of 1933-34, it was found on the Idaho prairies near Nezperce, where it occurs but is so inhibited during most years as to be unrecognized. In addition to western Oregon, it occurs also in trace amounts in the Grand Ronde Valley, Oregon. In 1930 it was found in irrigated spring wheat at Jerome, Idaho (Sprague, 621).

Take-all appears to be native in the Pacific Northwest, although it was not noticed until 1901 at Albany, Oregon (Cordley, 129)[4]. It occurs in virgin soils on Holcus lanatus L., high in the hills of the Coast Range in Oregon and has been found on Bromus orcuttianus Vasey in the Siskiyou Mts., Oregon. It is particularly common on annual fescues (Festuca dertonensis (All.) Aschers. and Graebn., F. megalura Nutt., F. myuros L.) in the Willamette Valley, in Newberg sandy loam, and in the greenhouse at Corvallis, Oregon, it is a nuisance in unsterilized soil. While O. graminis is important mainly on winter wheat and winter barley, it has been collected also on winter oats in acid soil in coastal Oregon and California. It was relatively common on these hosts during the year 1933-34 and was found in the Willamette Valley as well as along the coast. A trace of take-all was noted on Poa canbyi (Scribn.) Piper at Pullman, Washington. Fraser, Simmonds, and Russell (238,a) believed that O. graminis was indigenous to north-central Alberta.

The work of Fellows, Garrett, and the Canadian and Australian workers, has made O. graminis one of the most thoroughly studied fungi in the cereal rootrot complex. It needs plenty of study as it is a very uncertain parasite, here today and gone tomorrow. The worst infection the writer has ever encountered was in a plot of wheat seeded on land that had been in orchard for two decades or more.

Garrett's text (257) deals thoroughly with this fungus.

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[4] The still unlabeled specimens of this 1901 material were seen by the writer in 1933. They were definitely Ophiobolus graminis.

References: Åkerman et al. (3); Adam and Colquhoun (5); Broadfoot (69, 70, 71); Brommelhues (76); Buddin and Garrett (80); Bussman (85); Carne and Campbell (91); Clark (115); Cordley (129); Dana (137); Davis, R. J. (145); Fellows (223-228); Fellows and Ficke (230); Foster and Henry (236); Fraser (238); Fraser, Simmonds, and Russel (238,a); Garrett (242-258); Garrett and Dennis (259); Glynne (263); Griffiths (294); Henry (323); Hynes (346); Kirby (383); Laar, van de (395); Lal (396); Ludbrook (414); Ludwig and Henry (415); Mackie (423); Mangin (432); McAlpine (443); McKinney (446); McKinney and Davis (447); Melchers and Sewell (458); Moritz (474, 475); Müller-Kögler (478); Nattrass (480); Noll (490); Osborn (496); Padwick (498,499); Padwick and Henry (501); Robertson (537); Russell (548, 549); Samuel (573); Sanford (578); Sanford and Broadfoot (579); Simmonds (608); Simmonds, Russell and Sallans (611); Sprague (621); Stevens (683); Stumbo et al. (691); Turner (720, 721); Walker (750); White (764, 765); Winter (769-772, 774).

PHYLLACHORA SPP., Tar Spots.

The black, usually elongate, tar-like spots on grass leaves caused by various species of Phyllachora are classed as leaf spots. However, they represent a specialized group and as such have been carefully monographed recently by Orton (495). Since virtually all of the western material, including that of the writer, is discussed by Orton it is deemed satisfactory to refer this group to his work rather than discuss the group individually here. The publication (Mycologia) is readily available.

The tar spots are widespread and sometimes moderately important in reducing foliage, particularly on species of Muhlenbergia and on Elymus canadensis in our area. Studies on the life history of these forms is needed, particularly in reference to associated conidial and pycnidial forms.

Reference: Orton (495).

PYRENOPHORA BROMI (Died.) Drechs.

(The writer prefers to discuss this fungus under its conidial stage, Helminthosporium bromi Died., as it is one of a large number of species in this genus.)

SCLEROTINIA HOMOEOCARPA F. T. Bennett, Sclerotinia Turf Rot.

Bennett (38) in England concluded that his earlier described Rhizoctonia monteithianum F. T. Bennett (36) was a species of Sclerotinia. R. monteithianum was said to be the same as the small Rhizoctonia turf or greens disease known generally as dollar spot (Monteith and Dahl,472).

Since dollar spot occurs on the eastern edge of our area, S. homoeocarpa is included until critical work is available to verify or reject this classification. Probably the same fungus or fungi occur west of the Cascades in Oregon and Washington.

References: Bennett (36, 38); Keil (379); Monteith and Dahl (472); Struble (690); Tervet (704); Tyson (725).

BASIDIOMYCETES

ENTYLOMA SPP., Blister Smut on Leaves of Bluegrasses

The blister smuts of Poa spp. should be mentioned here because they can be and have been confused with tar spot fungi (Phyllachora). The stroma-like sub-epidermal chlamydospores form gray-black blister-like areas on the leaves of Poa pratensis, P. compressa, P. juncifolia, and P. annua in Oregon and adjacent Washington. The conidial phase of the fungus forms a fine, dried, amorphous series of dots scattered seriately along the surface of the blisters. The Ramularia-like sporidia of Entyloma irregulare Johans. from Poa annua germinated readily on potato-dextrose agar and produced flesh-color mucose masses of sporidia.

Entyloma spp. (E. bingenensis Zundel, in herb.) occurs abundantly on Poa vaseyochloa along the rocky warm slopes near Bingen, Washington, in late February or usually in March, as soon as growth starts and the first flowers appear (cfr. O.S.C. 8079, collected Feb. 25, 1935).

The two species, Entyloma crastophilum Sacc. and E. irregulare, are widely distributed but are especially prevalent, as mentioned, in western Oregon and Washington. They occur in the northern Great Plains and Minnesota. (?) E. spragueanum Zundel (782) from North Dakota is a fragment, needing further study. The entire group needs study.

References: Sprague (655, 656) Zundel (782).

CORTICIUM FUCIFORME (Berk.) Wakef., Pink Patch.

The fungus known generally as Corticium fuciforme but whose taxonomic status appears to be most uncertain has been reported by the writer from western Oregon (647). It develops on chewings fescue lawns during rainy periods in early spring. It also occurs on wild annual fescues, particularly Festuca myuros L. in Oregon.

References: Erwin (220, 221); Sprague (647).

RHIZOCTONIA SOLANI Kuehn,
Sharp Eyespot, Sheath Spot, Rootrot and Stem Canker (Strawbreaker), Brown Patch.

D. P. Rogers (538) places the basidial stage of R. solani in Pellicularia filamentosa (Pat.) Rogers based on Hypochnus filamentosus Pat. He gives Corticium vagum var. solani Burt ex Rolfs as a synonym, but C. vagum Berk. and Curt. is recognized as a common mold on woodland debris and is assigned to Pellicularia vaga (Berk. and Curt.) Rogers ex Linder. Because most of our material has not been connected with P. filamentosa, it is easier to employ the well-known R. solani for the purpose of this report.

R. solani is prevalent in most soils, particularly acid ones. It attacks a large number of grass hosts during wet weather in the spring. The damage usually is slight, mostly mild root necrosis or slight stunting; or sometimes elliptical light-colored eyespots with brown borders occur on the sheaths or culm bases. Under favorable conditions, the fungus may be rather destructive on cereals, causing deep-seated lesions at the ground line, which under stress of wind cause straw-breaking at this point. This condition was noted in one variety of wheat at Mandan in 1943 (Sprague, 663). An exceptionally virulent race of R. solani causes considerable damage in acid soils in the coast region in Oregon (Sprague, 623, 633, 663). The coastal fungus was erroneously assigned to an utterly different fungus by the writer in 1934 (623) although he had, before receiving mislabeled Italian material, properly listed this fungus as R. solani. The Oregon material from the coast is definitely a distinct race, both in its very strong pathological traits and the light, somewhat fluffy type of growth it makes in culture. The Oregon strain or race may be similar to Italian material, in fact the culture which the writer sent to Italy looked very much like the one which was later sent to him from northern Italy. Glynne and Ritchie (268) report similar symptoms on wheat from England and Wales. They believe that Cort's "sharp eye spot" (494) is the same fungus. They mention that Blair, working with some Canadian strains of R. solani, found some that caused stem girdling. They state that sharp eyespot does not increase with the frequency of wheat or barley in the rotations. It is as common in the first wheat crop as it is on old, arable land. The writer has long recognized that this fungus is difficult to control by crop rotation because of its ability to develop on so many hosts. In some places in Oregon cereals have been employed to clean up the soil in preparation for seeding Rhizoctonia-susceptible crops in following seasons. This may not be entirely successful. It is interesting to note that much of the detailed study in recent years on racial differences in R. solani (Houston, 341) has not considered the forms on Gramineae, the most widespread host family.

Hynes describes "purple patch" disease of cereals in Australia due to Rhizoctonia solani (344, 347) wherein small to extensive areas in a field have stunted, stiffened, slightly purplish plants with rotted

roots. Dillon Weston and Garrett (171) discuss a similar condition in England and state that the culm is not attacked as has been discussed by Glynne, Sprague, and also Oort as noted above. Samuel and Garrett (574) reported Rhizoctonia on cereals in Australia as early as 1932, and Dana (137) mentions it from western Washington in 1919.

Foëx and Rosella (235) described Sclerotium constantini Foëx and Rosella on wheat, which is the same as the stem-canker-causing strain of R. solani (Sprague, 663).

In addition to R. solani and its several races, the writer (663) has mentioned other species of this genus that need taxonomic study.

Brown patch is a case of an attack by Rhizoctonia solani in a crowded host colony wherein the fungus is able to spread from a central point, leaving dead brown areas of grass. Brown patch is important in lawns in Minnesota and in the coast region of Oregon and Washington, as well as elsewhere. In Oregon, R. solani is a common leaf rot of a large number of species of grasses during the humid winter months. It was a serious pest in spray chamber inoculation experiments at Corvallis during the years the writer was studying Septoria leaf spots of grasses. It was particularly destructive to leaves of Holcus lanatus, Agrostis alba, A. tenuis, A. palustris, and barley.

References: Bertus (44); Blair (51, 52); Dana (137); Dickinson (158); Dillon Weston and Garrett (171); Foëx and Rosella (235); Garrett (257); Glynne and Ritchie (268); Hearn (320); Hynes (344, 347); Jaarsveld (358); Matz (442); Oort (494); Peltier (508); Peyronel (515); Rogers (538); Ryker (553); Samuel and Garrett (574); Sanford (577); Shaw and Ajrekar (602); Sprague (623, 633, 645, 663); Voorhees (747).

SCLEROTIUM RHIZODES Auers.

Most of the western material originally assigned to Sclerotium rhizodes (Hungerford, 343) or to S. fulvum Fr. (Young, 777) has been shown to belong to Typhula spp. (Remsberg, 532, 533). One specimen on leaves of Agrostis alba collected in the Yellowstone National Park, Wyoming, in 1941 by Fischer may be left in S. rhizodes for the present. The sclerotia were black, differing from the tawny to hazel brown sclerotia of Typhula itoana Imai and the small chestnut brown ones of T. idahoensis. In a footnote to one of her articles, Remsberg (532) states that H. H. Whetzel lists, in unpublished data, S. rhizodes under Rhizoctonia.

References: Hungerford (343); Kreitlow (391); Remsberg (532, 533); Stirrup (687); Stout (688, figs. 1-8); Young (777).

TYPHULA SPP., Snow Molds.

After many years of confusion, the snow mold of winter cereals in certain areas in Idaho and Montana have been shown to be caused by two species of Typhula, T. itoana Imai and T. idahoensis Remsberg (Remsberg, 532, 533). The fungi develop on over-wintered rosettes of wheat and certain grasses. After the snow has melted the plants are found covered with a moldy white fungous growth and the tissue is filled with small reddish brown (T. idahoensis) or dark brown (T. itoana) sclerotia. These fungi occur in Idaho (Hungerford, 343; Remsberg, 532, 533) and Montana (Young, 777 P. idahoensis), while T. itoana is recognized in the eastern United States (Wernham, 761) and Minnesota (Tervet, 703). The writer (656) noted sclerotia similar to T. idahoensis on Bromus tectorum L. and B. mollis L. on High Prairie, Washington. Snow mold material on wheat sent from Badger Mt. near Waterville, Washington, appeared to have a conidial stage that resembled that of Sclerotinia graminearum Elen. (Solkina, 618), which is a winter parasite of grain in Russia. Later reports indicate, however, that this fungus is a species of Typhula.

Remsberg noted that T. graminum Karst. is distinct from the Idaho fungi and that Sclerotium fulvum is the same as T. itoana and not related to T. graminum, as shown by differences in the structure of the sclerotia of each. T. borealis Ekstrand, which was incompletely described, is apparently the same as Remsberg's T. idahoensis.

References: Ekstrand (201, 202); Heald (315); Hungerford (343); Imai (350, 351); Müller (477); Remsberg (532, 533); Remsberg and Hungerford (534); Solkina (618); Sprague (656); Tervet (703); Volk (746); Wernham (761); Young (777) Young and Morris (778).

NON-SPORULATING BASIDIOMYCETES, Snow Mold and Root Necrosis.

Broadfoot and Cormack (73) report a snow mold-like gray fungus on over-wintered grasses, winter wheat, and alfalfa in Alberta. This fungus is very parasitic at low temperatures. They state, "This pathogen grows readily on most nutrient media at temperatures from 0° to 18° C., producing a fluffy, white sterile mycelium. Cardinal temperatures for growth are -4°, 15°, and 26° C. Sclerotia, fruiting bodies, and spores have not been found on the diseased host plants, and many attempts to produce them in culture under varying conditions of temperature, light, moisture, and nutrient media have failed. The characteristic clamp connections of the mycelium and the occasional production of small rudimentary sporophores on culture media indicate that the fungus is a basidiomycete."

Another non-fruiting basidiomycete has been isolated from crested wheatgrass (Agropyron cristatum) in Minnesota by Andrews (15), and from

A. sibiricum, A. elongatum (Host.) Beauv., Elymus canadensis, and crested wheatgrass at Mandan, North Dakota, (Sprague, 663), and on slender wheatgrass (A. trachycaulum) near Medora, North Dakota. It has been isolated also from crested wheatgrass collected near Wibaux, Montana. This fungus is a weak parasite on grasses, causing a slow root necrosis and yellowing of the seedlings. It develops during the summer and fall, as far as it is known at present. It produces a white cottony growth on potato-dextrose agar.

References: Andrews (15); Broadfoot and Cormack (73); Sprague (663).

FUNGI IMPERFECTI

Because there are so many species of Fungi Imperfecti on Gramineae and because some of them have such extensive host ranges, the entire group represents a very complex problem, considered from the viewpoint of the plant pathologist as well as the mycologist. It will be obvious to the reader that considerable fundamental work needs to be done with this heterogeneous group.

In order to bring related fungus genera together, the following grouping is followed:

A Spores borne in pycnidia-----(1) Sphaeropsidales, p. 120

AA Spores borne in acervuli-----(2) Melanconiales, p. 168

AAA Spores borne otherwise-------(3) Moniliales, p. 172

1. SPHAEROPSIDALES

ASCOCHYTA SPP., Leaf Spots.

The writer and A. G. Johnson have prepared but not yet published (674) a taxonomic study of the species of Ascochyta that occur on Gramineae in the western region. It appears desirable to submit the key to these forms, which will appear in a later publication. Ascochyta is considered here as including species with hyaline spores and also those with yellow spores (Ascochytula and Ascochytella), as well as certain species previously assigned to Diplodina, which genus is not distinct from Ascochyta (see also Diedicke, 166).

The characters principally used in segregating the fungi studied in this report are included in the following key:

A. Spores finally yellow or yellow-brown, pycnidia dark............ Sect. <u>Ascochytula</u>

B. Spores definitely fusoid, ends somewhat pointed; strongly yellow-brown, 18-27 x 5-7.7 µ. On <u>Hordeum</u> <u>vulgare</u> and <u>Holcus</u> <u>lanatus</u> .... <u>Ascochyta</u> sp.

BB. Spores irregularly cylindrical, sometimes 2-septate, 17-26 x 6.2-7 µ, tardily yellow. On <u>Avena</u>......................... <u>Ascochytella</u> <u>avenae</u> Petr.

BBB. Spores sub-cylindric, ends rounded, 14-19 x 4.5-6.2 µ in summer material (larger in type). On <u>Agropyron</u> and <u>Elymus</u> .... <u>Ascochyta</u> <u>agropyrina</u> (Fairm.) Trott.

AA. Spores hyaline or only chlorinous, rarely yellow, pycnidia brown

B. Spores sometimes over 4.2 µ in diameter

C. Spores very broad, as much as 8 µ diameter

D. Pycnidia 80-120 µ, spores ovate fusoid, ends acute, 15-19 x 6-8 µ. On <u>Panicum</u> <u>virgatum</u> L. .... <u>Ascochyta</u> sp.

DD. Pycnidia 190-200 µ, spores sub-cylindric, ends obtuse, 16-23 x 6.5-9 µ

E. Spores 16-19 x 5-7 µ. On <u>Sporobolus</u> <u>airoides</u> (Torr.) Torr. .... <u>A.</u> <u>stipae</u> Died.

EE. Spores 17-23 x 6.5-9 µ. On <u>Stipa</u> sp. .... A. <u>stipae</u> Died.

CC. Spores 6-7 µ wide .... <u>A.</u> <u>boutelouae</u> Fairm.

CCC. Spores (in our material) typically less than 6.5 µ broad

D. Spores short cylindric or ovate, 11-18 x 3.5-5 µ. On <u>Distichlis</u> .... <u>Diplodina</u> <u>graminea</u> Sacc.

DD. Spores cylindric or oblong, 16-23 x 4-5.3 µ. On <u>Festuca</u>, <u>Phalaris</u>, <u>Pleuropogon</u>, <u>Stipa</u>, etc. .... <u>A.</u> <u>graminicola</u> var. <u>brachypodii</u> Trail

DDD. Spores spindleform, ends acute, 17-21 x 4.2-5µ, finally subcylindric. On <u>Andropogon</u> and <u>Sorghastrum</u> .... <u>A.</u> <u>graminicola</u> var. <u>brachypodii</u> Trail

BB. Spores seldom exceeding 4 µ in diameter

C. Spores 11-20 x 2.5-4 µ, scarcely narrowly cylindrical

D. Spots pale brown or with red borders, usually scattered

E. Spores mostly 11-16 x 2.5-4 µ

F. Spores 11-16 x 2.5-4 µ, ovate or subcylindric .... A. graminicola Sacc.

FF. Spores 11-13 x 3.2-3.9 µ, short cylindric .... A. sorghi Sacc.

EE. Spores typically longer, cylindrical, 14-20 x 2.5-4 µ .... A. graminicola var. holci Sacc.

DD. Spots chocolate brown, often numerous, spores cylindrical and similar to A. graminicola var. holci or shorter, but pycnidia larger. On Bromus spp. .... A. graminicola var. diedickeana Baudyš and Picb.

CC. Spores 11-24 x 1.5-3.0 µ, narrowly cylindrical to sublanceolate

D. Spores sometimes sublanceolate, typically with 1-2 small oil drops adjacent to the cross wall, 12-24 x 2-2.8 µ, in pale spots on Poa spp. .... one-septate phase of Septoria oudemansii Sacc.

DD. Spores typically cylindrical

E. In brown lesions, spores 11-18 x 2.4-3.1 µ ...... A. desmazieri Cav.

EE. In paler lesions, spores 11-18 x 1.5-3 µ in very pale brown thin-wall pycnidia .... A. elymi Tehon and Daniels

EEE. In tawny spots in brown pycnidia, spores very narrow, 11-16 x 1.5-2.2 µ. On Phleum pratense L. .... Ascochyta sp.

ASCOCHYTA sp. on Hordeum and Holcus, Leaf Spot and Leaf Rot.

Over-wintered leaves of barley and velvet grass (Holcus lanatus) in

Klickitat County, Washington, show pale gray emarginate spots with prominent black pycnidia. The spores are light brown, fusoid-cylindric, often pointed at both ends, 18-24 x 5-6.8 µ, and have coarse granular contents. It is fairly common on High Prairie, Washington, but does not appear to be of very much importance (Sprague and Johnson, 674). It appears in the spring of the year just after the snow has left the rosettes of the over-wintering plants. What appears to be the same species occurs on Agropyron smithii in North Dakota.

ASCOCHYTA sp. on Panicum, Leaf Rot.

Our material of this fungus consists only of a fragment on frost-injured leaves of Panicum virgatum L. and on P. dichotomiflorum Michx. from North Dakota. The spores are short, thick, lemon-shape with sharp ends and slight constriction at the septum. It is probably saprophytic or very weakly parasitic (Sprague and A. G. Johnson 674).

ASCOCHYTA sp. on Phleum pratense L.

This fungus occurs on leaves of timothy in a swamp near Niawa, Minnesota. The tawny leaf spots contain brown pycnidia with very narrow spores 11-16 x 1.5-2.2 µ.

References: Sprague and A. G. Johnson (674); Sprague (668).

ASCOCHYTA AGROPYRINA (Fairm.) Trott., Leaf Spots.
(Ascochytula agropyrina Fairm.)

This very weak parasite or saprophyte has yellowish-brown spores that would place it in Ascochytula, but Trotter (Saccardo, 558, V. 25) places this genus as a sub-genus in Ascochyta which appears to be logical. A. agropyrina is widely scattered and common but never occurs in great abundance in any material. It has been found on Agropyron bakeri E. Nels. in New Mexico (Fairman, 222); on A. caninum (L.) Beauv. (from Russian seed), A. cristatum, A. michnoi Roshev, A. semicostatum (Steud.) Nees, A. subsecundum (Lk.) Hitchc., A. trachycaulum, A. trichophorum (Lk.) Richt., Elymus canadensis, and E. virginicus in North Dakota; A. cristatum and A. smithii in Montana; and on A. semicostatum from Pullman, Washington. The material from Pullman has fuscous spots with red to vinaceous borders but the spores are pale yellow and with the stout cylindrical shape of A. agropyrina.

References. Fairman (222); Saccardo (558) v.25; Sprague and A. G. Johnson (674); Trotter (713).

ASCOCHYTA BOUTELOUAE Fairm., Leaf Mold.

Scarcely parasitic, a relatively common fungus on the leaves of blue grama in central North Dakota and in New Mexico. The spores in this species are thicker than those of A. graminicola, somewhat near A. graminicola brachypodii but the black, often sub-superficial (saprophytic), tardily ostiolate pycnidia, together with a hint of smokiness in the spores, distinguish A. boutelouae from A. graminicola var. brachypodii (Sprague and A. G. Johnson, 674). A. boutelouae is scarcely distinguishable morphologically from Diplodina graminea Sacc. (Sprague and A. G. Johnson, 674). Fairman (222) described this from New Mexico.

ASCOCHYTA DESMAZIERI Cav., Leaf Blotch.
(Septoria lolii West. and Diplodina lolii Zimm.)

The fungus causes a brown or brownish purple spot on the leaves of Lolium perenne L. and L. multiflorum in Oregon, Washington, and California. It is sometimes destructive. The spores are truly cylindrical and readily distinguished from those of the A. graminicola complex. Its symptoms are readily distinguished from the speckled gray blotch caused by Septoria tritici var. lolicola Sprague and A. G. Johnson (665), but can be confused with those of S. loligena Sprague. It should, in fact, be compared critically with this fungus.

References: Cavara (99); Sprague (655; 665); Sprague and A. G. Johnson (674); Zimmerman (781, (p. 101).

ASCOCHYTA ELYMI Tehon and Daniels, Leaf Spot.

Tehon and Daniels (701) distinguish this species from A. graminicola by its fragile pycnidia as contrasted with the brown ones of A. graminicola. The writer has found A. elymi on seedlings of Elymus canadensis near Solen, North Dakota. Traces of it occur on Elymus spp. in the Rocky Mountains and possibly on Agropyron repens near Eugene, Oregon.

ASCOCHYTA GRAMINICOLA Sacc. and Varieties, Leaf Spots.

Davis' summary of the common parasite, A. graminicola, is generally accepted (Davis, 140). While the fungus usually is limited to a few red-bordered brown or fawn-colored spots on the lower leaves or leaf tips, the fungus is sometimes aggressively parasitic. Such material has been seen on Hierochloë odorata (L.) Beauv. in North Dakota and South Dakota. In the far west it is common or more often scattered on a number of grasses during the rainy season in winter and spring, while east of the Rockies it develops during rainy periods in the summer

(Sprague, 655, 656).

Some 14 varieties have been described for *A. graminicola*, but these include some "varieties" which are readily referable to *Darluca filum* (Biv.) Cast. In fact, it is conservative to say that a majority of the specimens in herbaria that are assigned to *A. graminicola* are *D. filum* or sometimes immature stages of *Hendersonia*, *Stagonospora*, or *Septoria*. Among the recognizable varieties of *A. graminicola*, var. *holci* is considered to have somewhat larger spores than true *A. graminicola* and much of our western material would fall under this variety if it is recognized. A more obvious form, var. *brachypodii* Trail (708), occurs on *Phalaris arundinacea* L. at Mandan, North Dakota; on *Lolium perenne* L. from Troutdale, Oregon, on *Stipa comata* Trin. and Rupr. in Montana, on *Andropogon furcatus* Muhl, at Mandan, North Dakota, and on *Pleuropogon refractus* (A. Gray) Benth. in Oregon (Sprague and Johnson 674). These all tend to have fusoid spores, 15-17 x 5 µ, while the species proper and var. *holci* have narrower spores that are nearly cylindrical, 10-20 x 2.5-4 µ.

Var. *diedickeana* Baudyš and Picb. (26) produces brown-bordered lesions with paler centers, and in severe cases dark brown or nearly black general scalding of affected green parts. It occurs on *Bromus carinatus* in Oregon, on leaves of *B. inermis* in Minnesota, and on roots of *B. inermis* in North Dakota (see also Broadfoot, 72). It occurs on *Hordeum nodosum* L. at Hunter, Alaska. In addition to its distinct symptoms and parasitic tendencies, this variety is recognizable to some extent by its cylindrical to fusiform spores, 11-17 x 2.5-3.1 µ, which are narrower than those of var. *holci*.

Ascochyta graminicola is indeed a complex, and further life history studies may show that some of these morphologically similar forms are growth stages of entirely different fungi.

References: Baudyš and Picbauer (26); Broadfoot (72); Davis (140); Sprague (655,656); Sprague and A. G. Johnson (674); Trail (708).

ASCOCHYTA SORGHI Sacc., Leaf Spot.

What can be called this fungus was collected on sorghum at Brookings, South Dakota, in 1912 by C. R. Ball and determined by the writer 30 years later. The spores are small and cylindrical, 11-12.5 x 3.2-3.9 µ.

ASCOCHYTA STIPAE Died., Leaf Spot.

A prominent maroon to vinaceous leaf spot occurs on *Stipa* sp. on Mt. Shasta, California. The broad spores are 17.5-24 x 6.5-9 µ. Another collection on *Sporobolus airoides* from Pullman, Washington, has smaller spores but they are similar in shape to those on *Stipa* (Sprague and

Johnson, 674).

ASCOCHYTELLA AVENAE Petr., Leaf Spot.

This fungus which was placed in still another genus (Ascochytella) by Petrak (510, p. 107) belongs in the yellow-spored section or subgenus Ascochytula of Ascochyta. It was found once in late winter on Avena byzantina C. Koch (red oats) near Troutdale, Oregon, and on A. fatua (wild oats) at Pullman, Washington (Sprague and A. G. Johnson, 674).

CONIOTHYRIUM PSAMMAE Oud., Leaf Spot.

Coniothyrium psammae occurs scatteringly along the sea coast in Oregon on Calamagrostis nutkaensis (Presl) Steud. The spots are large, elliptical, light buff with prominent vinaceous borders. The pycnidia are few and contain brown elliptical spores, 10-13 x 3-4 µ.

Reference: Sprague (652).

DILOPHOSPORA ALOPECURI (Fr.) Fr., Twist Disease.

The leaves and more often the heads are attacked. The fungus causes a black, charred-appearing crust accompanied by deformation and twisting of the head and adjacent leaves. Affected heads are frequently killed in the boot. The fungus develops abundant black masses of pycnidia, which produce spores with characteristic bristle-like appendages at both ends. The spores are hyaline, 8-15 x 1.6-2.5 µ; and the appendages are 5 to 7 µ, less often 10 µ long and 0.5 µ thick at the base, 3-4 branched with some branches forked or sometimes tri-furcate.

Atanasoff (18) has detailed a study wherein he suggests that the spores are carried by Tylenchus tritici (Steinb.) Bast. to the growing points of the plant. This appears to be discounted by many writers. Certainly in the Pacific Northwest the twist disease does very well without the assistance of nematodes in most cases.

Some workers, including Rainio, claim that Mastigosporium album Riess and D. alopecuri are part of the same life cycle. This is utterly incorrect (Sampson and Western, 570; Sprague, 640). No proof of connection with Dilophia graminis Sacc. has been obtained in this country either.

Dilophospora alopecuri is common in Oregon and Washington on Holcus lanatus and Sitanion jubatum J. G. Sm. and it occurs on Agropyron inerme in eastern Washington; on A. smithii in Idaho; on A. spicatum in Montana; on A. trachycaulum in Yellowstone Park, Wyoming, and Roosevelt Park,

North Dakota, on Melica bulbosa Geyer in Yellowstone Park; and on Poa secunda at Logan, Utah. Most of the collections have been made recently by Fischer and the writer but the fungus has been present in the West for an indefinite period. Jackson collected it in Oregon in April, 1915 (O.S.C. 10,530). Bessey (45) reported it from Wisconsin in 1906.

Bevilacqua (46) recommends that the wheat be cut high, the stubble burned, and the seed treated.

Reference: Atanasoff (18); Bessey (45); Bevilacqua (46); Grove (296); Kotte (389); Raino (520); Sampson and Western (570); Schaffnit and Wieben (585); Sprague, 640).

DIPLODIA ZEAE (Schw.) Lév., Dry Rot of Corn.

This dry rot of corn ears has been well discussed and illustrated by several workers in Nebraska (Heald et al., 318), Iowa (Durrell, 189), and the eastern States. The fungus also causes sheath and leaf spots and stalk rots, and the fungus in the seed causes seedling blight. The disease is important in Iowa, eastern Nebraska, and Minnesota but disappears in the West although it probably occurs in favored, more humid areas.

References: Bijl (47); Burrill and Barrett (84); Clayton (116); Durrell (189, 190); Eddins and Voorhees (193); Heald (312); Heald et al. (318); Hoadley (332); Holbert et al. (336); Holbert, Hoppe, and Smith (337); Hoppe (338); Kent (381); Kinsel (382); Koehler and Holbert (388); Larsh (398); McNew (451); Raleigh (521); Semeniuk (590-593); Semeniuk et al. (596, 597); Ullstrup (728); Valleau et al. (735); Wilson (767).

DIPLODINA GRAMINEA Sacc., Leaf Mold.

Material collected by the writer at Davis Junction, California, on Cynodon dactylon (L.) Pers. shows sub-superficial pycnidia scattered among Helminthosporium cynodontis Marig. The spores of the Ascochyta are capsular, one-septate, clear hyaline but with a hint of smokiness in mass, 11-18 x 3.9-5 µ (Sprague and Johnson, 674). Diehl (169) reported the fungus from South Carolina in 1935, the first report for the western hemisphere. The fungus is probably common. Nothing is known as to its pathogenicity. See also A. cynodontis Unam. (730).

HENDERSONIA SPP., Molds.

Some of the common invaders of dead or dying tissue are species of Hendersonia Berk. em. Sacc. Therefore, in routine examination of diseased plants, workers are confronted with scattered pycnidia belonging

to species of this genus. The brown spores of Hendersonia are broadened, not filiform nor elongate-vermiform as in some species of Phaeoseptoria (Sprague, 659). Since this group does not contain any species that are definitely parasitic it is not considered necessary to discuss them in detail. In addition the taxonomy of this group is in great confusion, at least from the viewpoint of literature available on the western forms. The writer has an uncompleted manuscript dealing with about 16 species in the Western States (667). They are particularly common on overwintering grasses in the Pacific Northwest and Rocky Mountain areas and on grass in the late fall in the Northern Great Plains.

Among the common species of Hendersonia are H. simplex Schroet., H. culmicola Sacc., H. crastophila Sacc., H. calamovilfae Petr., H. stipae-pennatae Fautr., and H. calospora Fautr. Several less common or undescribed species also occur.

The following is a simplified key to these species:

A. Spores when mature typically 7-septate.

B. Pycnidia very large, 180-300 µ in diameter

C. Spores falcate or falcate-fusiform, 28-40 x 3.8-4.4 µ .... Wojnowicia graminis

CC. Spores fusiform, vermiform, coarse, somewhat constricted at the septa, 35-53 x 3.5-5 µ ...... H. calospora Fautr.

BB. Pycnidia smaller, 80-220 µ in diameter

C. Spores regularly cylindrical, ends blunt, cross walls closely adjacent, 20-29 x 4-6 µ .... H. stipae-pennatae Fautr.

CC. Spores more or less fusiform, sub-cylindrical; ends or at least one end somewhat to definitely tapered; septa not particularly closely adjacent

D. Spores as much as 7 µ wide ... H. calamovilfae Petr.

DD. Spores mostly 3-5 µ wide

E. Spores brown, fusiform or falcate, flattened on one side, constricted at the septa

F. Spores fusiform, pycnidia rarely with hairs on the ostiolar end .... H. crastophila Sacc.

FF. Spores fusiform-falcate or falcate, pycnidia with scattered hairs on the ostiolar end ..... Wojnowicia graminis (McAlp.) Sacc. and D. Sacc. (Confusable with H. crastophila when immature)

EE. Spores lighter colored, small paired regularly placed prominent guttulae, often constricted at septa, sub-cylindrical, ends conical, not stiffly flattened on one end .... Hendersonia sp.

EEE. Spores shorter than in EE, rarely constricted at septa, more often 5- than 7-septate .... H. culmicola Sacc.

AA. Spores when mature typically 5-septate or less (see also H. culmicola above)

B. Spores sometimes more than 3-septate, cylindrical

C. Spores 3-, 5-, to 7-septate, 30-38 x 3.1-4.2 µ........... H. culmicola Sacc.

CC. Spores 3- to 4-septate, 20-27 x 3.2-3.4 µ .... H. culmicola var. intermedia Sacc.

BB. Spores not more than 3-septate

C. Spores with stout epispores, 6.2-7.8 µ wide .... Hendersonia sp.

CC. Spores with thin walls, less than 5 µ wide

D. Spores 28-48 x 3.8-4.3 µ .... Hendersonia sp.

DD. Spores less than 30 µ long or approximately that

E. Spores short-cylindrical, some at least 4 µ wide

F. Spores 22-29 x 2.8-4.6 µ .... H. agropyri-repentis Oud.

FF. Spores 15-20 x 4.3-4.8 µ .... Hendersonia sp. on Danthonia intermedia Vasey

EE. Spores sub-cylindric to fusiform, not over 3-5 µ wide

F. Spores often 1-septate, finally 3-septate, sub-lanceolate at first, 17-22 x 2-2.6 µ......... H. culmicola var. minor Sacc.

FF. Spores mostly 3-septate, sub-bacillar, 14-26 x 2.3-3.1 µ .... *H. simplex.* Schroet.

The closely related species *Wojnowicia graminis* is included in the key for comparison.

References: Grove (297); Saccardo (558, v. 3, 10, 11, 12, 13, 14, 16, 18, 22, 25); Sprague (667).

MACROPHOMA PHLEI Tehon and Stout, Leaf Mold.

What was probably saprophytic material of *M. phlei* was seen at Mandan, North Dakota, on *Elymus triticoides* Buckl. on October 1, 1943 (B.P.I. 80,893). Spots were diffuse straw-color, or more often absent. The pycnidia were black, depressed, globose, 120-135 x 120-204 µ bearing elliptical to elongate ovate spores, which were slightly larger at one end, with pure white opaque contents, 28-39 x 8.5-11.1 µ, mean size 32 x 9.4 u. This compares with 18-26 x 6.4-7.7 µ for the type of *M. phlei*, which indicates that the Mandan material has somewhat larger spores but is probably the same species. *M. phlei* has also been seen on *Agrostis palustris* from Waldport, Oregon, with spores 24-31 x 9.5-11 µ.

References: Sprague (666); Tehon and Stout (702, p. 188).

MACROPHOMINA PHASEOLI (Maubl.) Ashby, Charcoal Rot.
(*Sclerotium bataticola* Taub.)

Charcoal rot develops in the stalks of corn and sorghum in late season, causing general decay and weakness with the resultant breaking over of diseased plants. The numerous small black bodies form in large numbers. These are said to be prosenchymatous-filled pycnidia or sclerotium-like bodies of the Sphaeropsidaceous *Macrophomina phaseoli*. *M. phaseoli* occurs on corn in California (Mackie, 426) and recently has been given considerable publicity in Nebraska (Livingston, 409, 410), Iowa (Semeniuk, 594) and adjacent states. It has not been isolated, as yet, from North Dakota material, although a sclerotial form superficially resembling it has been obtained from roots of several grass crops at Mandan.

References: Ashby (17); Dunlap (188); Haigh (304); Hoffmaster et al. (334); Livingston (409, 410); Schwarze (587, p. 148-149); Semeniuk (594, 595); Taubenhaus (699); Tehon and Boewe (700); Uppal et al. (733).

PHAEOSEPTORIA Spp., Leaf Molds and Secondary Invaders.

Species of this genus sometimes are encountered on dead or dying leaf and culm tissue of grasses. *Phaeoseptoria* belongs to the Scolecosporae,

has coarse black pycnidia and light brown multiseptate spores. A key to all known forms of this genus on grasses and a discussion of their taxonomy has recently appeared (Sprague, 659) and it seems unnecessary to repeat this information here as the group is of little economic importance.

PHOMA SP.

An undetermined species of Phoma was reported as important on Agropyron smithii Rydb. in Utah by O'Gara (493).

PHOMA TERRESTRIS Hansen, Pink Root.

The same fungus that attacks the roots of onions, causing pink root, is able to attack the roots of cereals and grasses (Kreutzer, 392). Johann (365) and Sprague (662) verified this and also isolated the fungus from Gramineae. It occurs in many species of grasses and cereals in the Northern Great Plains but is not very parasitic.

P. terrestris causes a pink to carmine-lake coloration of the roots. It sometimes causes mild seed rot and slight rootrot. In culture, it produces a slow-growing mounded gray colony with pink to magenta tints in the substrate. It does not fruit readily on potato-dextrose agar.

References: Carvajal (96); Johann (365); Kreutzer (392); O'Gara (493); Sprague (662).

PHYLLOSTICTA

Five species of Phyllosticta, not known to be phases of more complex fungi, may be distinguished by the following key:

A. Pycnidia in spots with pale centers

B. Spots small, white, spores 11-15 x 2.5-4.5 µ .... P. rogleri Sprague

BB. Spots irregular, pale to discolored, with red to purple borders, spores 4-7 x 2-3 µ .... P. sorghina Sacc.

AA. Pycnidia in gray or vague spots

B. Spots gray, elongate, spores bacillar, 2.3-4.6 x 1-1.4 µ.... P. owensii Sprague

BB. Spots vague on dead leaves, spores bacillar, 5-9 x 1-1.6 µ .... P. anthoxella Sprague

BBB. Spots cream color to pale yellow, emarginate, spores oval to elliptic, 6.5-8 x 3-4 µ.....P. avenophila Tehon and Daniels[5]

PHYLLOSTICTA ANTHOXELLA Sprague, Leaf Spot.

The small black pycnidia are scattered over **moldy** dry leaves of Anthoxanthum odoratum L. collected at Triangle Lake, Oregon (Sprague, 652, fig. 1, e). Little is known about this fungus, which appears to be of slight importance.

PHYLLOSTICTA OWENSII Sprague, Gray Leaf Streak.

Also a minor parasite or mold on living, dead or salt-spray injured leaves of Dactylis glomerata in the vicinity of Waldport, Oregon (Sprague, 652). It is an associate of Scolecotrichum graminis Fckl.

PHYLLOSTICTA ROGLERI Sprague, White Leaf Spot.

Known only on Digitaria sanguinalis (L.) Scop. from Albia, Iowa. (Sprague, 652, fig. 1, f).

PHYLLOSTICTA SORGHINA Sacc., Eyespot.
(Phoma insidiosa Tassi)

The lesions are irregular to sub-circular, pale straw to isabelline color spots with narrow purple to red borders, 3-8 mm in diameter. They develop during the summer rainy season and are associated with various bacterial and possibly non-parasitic spots on Setaria viridis in North Dakota (Sprague, 652, fig. 1, g).

SELENOPHOMA

The genus Selenophoma is characterized by pycnidia with non-septate, sickle shape (falcate), hyaline spores (Maire, 428).

Key to the species:

A. Spores acute, boomerang or arcuate

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[5] This fungus occurs in Illinois and Mississippi but is likely to be found in the area covered in this report.

B. Spores arcuate, typically 10-16 x 1.1-1.8 µ..................
S. everhartii (Sacc. and Syd.) Sprague and A. G. Johnson

BB. Spores lunate to boomerang, typically 18-30 x 2-4 µ ....
S. donacis (Pass.) Sprague and A. G. Johnson

BBB. Spores lunate to sub-arcuate, typically 12-24 x 1.5-2.7 µ ...
S. donacis var. *stomaticola* (Baüml.) Sprague and A.G. Johnson

BBBB. Spores lunate, 17-25 x 2-3.2 µ. On *Bromus* ....
S. bromigena (Sacc.) Sprague and A. G. Johnson

AA. Spores obtuse, sub-reniform-falcate ....
S. obtusa Sprague and A. G. Johnson

SELENOPHOMA BROMIGENA (Sacc.) Sprague and A. G. Johnson

The common host, *Bromus inermis*, is severely damaged by this fungus which forms gray, irregular to sub-circular spots on the leaves in early spring. It is especially prevalent in the Red River valley and in Minnesota but occurs westward to Pullman, Washington. It is not uncommon on the prairies in Idaho but has not yet been noted in Oregon or California. It appears to be rather largely confined to *B. inermis* growing in the plains countries. It occurs in Hungary (Krypt. Exs. Palatino, No. 1465) but has not been given much recognition outside the United States.

Selenophoma bromigena differs from *S. donacis* somewhat vaguely in that the spores of *S. bromigena* are regularly lunate, sharp-pointed, rarely boomerang shape. An undated packet of a fungus called *Phlyctaena bromi* by Clements (Crypt. F. Coloradensium) on *Bromus ciliatus* L. appears to be a saprophytic phase of *S. bromigena* on an unusual host. Allison (9) found that *S. bromigena* was confined to *B. inermis*. Field observations show that there are very few exceptions to this. *S. bromigena* has been collected in trace quantities on *B. carinatus* at Glenrock, Wyoming, Pullman, Washington, and Mandan, North Dakota.

References: Allison (8-10); Darley (138); Saccardo (557); Sprague and A. G. Johnson (673, 675, 676).

SELENOPHOMA DONACIS (Pass.) Sprague and A. G. Johnson.
(*Septoria oxyspora* Penz. and Sacc.)

This fungus is commonly known as *Septoria oxyspora*, less often as *Septoria donacis* Pass., an earlier name. While it was described on *Arundo donax* L., a giant reed, it occurs also on *Phalaris arundinacea* in Washington and North Dakota; rarely on *Phragmites communis* Trin. in

North Dakota; (Septoria curva Karst.) on Elymus condensatus Presl in Washington, North Dakota, and Oregon; on E. flavescens Scribn. and Sm. in Washington; on Panicum virgatum in the Great Plains; and on Stipa columbiana Macoun, S. comata, S. richardsoni Lk., S. spartea Trin., and S. viridula in the Great Plains and westward.

Selenophoma donacis on Arundo, Phalaris, and Elymus has spores averaging around 20-21 x 3 µ and more or less boomerang shape. Spores of S. donacis on Panicum are the same length as those on Arundo but are recognizable because of their narrower shape. They are 21.5 x 2.2 µ, mean size, in one collection. Those on Stipa are stubbier, 18.3 x 2.8 µ, average, and the material on Phragmites has thicker, short spores, 16-18 x 3-4 µ but typically boomerang shape.

Most of the lesions are straw color with tawny, fuscous, or lilac tinted borders, and contain small obscure pycnidia. Very often the spots fade, leaving the pycnidia in unspotted tissue on the culms, sheaths or leaves.

S. donacis has not been studied so thoroughly as its variety stomaticola, and therefore cannot be segregated into races. On cultural characters, it is indicated that there is a distinct race on Elymus flavescens from the sandhills near Hanford, Washington; one on Arundo from California; and probably the same race on Phalaris in the northern United States; another on Panicum; and probably two on Stipa. The culture from E. flavescens from Hanford, Washington, for instance, produces an ivory color growth quite different from the congo pink to testaceous rose mycelia from California material of Arundo donax. However, a race with narrower spores isolated from Panicum virgatum from material collected at Coburn, North Dakota, was very similar to the culture from Arundo (Sprague and A. G. Johnson, 675). Until there is more evidence to the contrary, all of these groups are placed under one species because the morphological differences between them are not fundamental.

References: Grove (296); Passerini (504); Penzig (509); Sprague and A. G. Johnson (673, 675).

SELENOPHOMA DONACIS var. STOMATICOLA (Baüml.) Sprague and A. G. Johnson. (Phyllosticta stomaticola Baüml.)

The complex that we place under this variety has, in general, spores that are 3-5 µ shorter than those of the species and are distinctly narrower. The problem is not so simple as that, however, because spores in some groups, such as that on Agropyron, approach or equal in size those of S. donacis on Panicum, while in others, as that on Sporobolus, they are close to the small-spored S. everhartii (Sacc. and Syd.) Sprague and A. G. Johnson. One group on Poa (cfr. Septoria nebulosa Rostr.) has short spores with sharper tips, while material on

Danthonia has evenly lunate spores with softly tipped ends. It is, nevertheless, difficult to segregate these groups into species on any satisfactory basis. Because of our present incomplete knowledge, it appears more practical to assign all of them to the earliest available name as a variety under S. donacis.

The symptoms induced by this variety are of two kinds, light color spots with pale, tawny, red or lilac borders, or no spots at all with the minute pycnidia scattered over straw-color areas. On Calamovilfa, in the Dakotas, the spots are particularly pale, while on Danthonia californica Bol. in Oregon, the spots are a "frog eye" type with a prominent red or maroon border. The lesions on rye (Secale cereale L.) are fuscous to straw color without prominent borders while the pycnidia are more prominent against the light background than on most other hosts.

Pure culture studies, plus examination of a large number of collections on western grasses, have shown that var. stomaticola is divisible into 11 major groups or major races as follows:

Race 1, on Danthonia californica, is closest to Septoria lunata Grove (296) with the regularly lunate spores with soft-pointed tips. It produces a light gray crustose colony with scant mycelium and opalescent grayish white spore droplets. The medium was tinted rosy-vinaceous. The fungus is restricted to this species of host.

Race 2, on Dactylis glomerata and Koeleria cristata from Pullman, Washington. The isolates from these two hosts are identical, each produces a lavender-tinted colony.

Race 3, on Festuca idahoensis from Lyle, Washington, has the appearance of race 2 in pure culture but the spores are narrower and resemble those of the next race.

Race 4, on Agropyron and Elymus spp. has spores that average slightly narrower and longer than those on most other hosts of this variety and they form a definite group.

Race 5, on Poa spp. The native species of Poa from the middle Columbia River Valley harbor a race that is similar in pure culture to race 2, but not identical with it, and with spores that are thicker in their middle portions and sharper at their ends.

Race 6, on Poa spp. from Pullman, Washington, and the Big Horn Mountains, Wyoming, tends to form cream color, soon tan, brown, creosote, and finally black colonies. These seem to represent a distinct group.

Race 7, on Poa pratensis from Quad Creek, Montana, is akin to

race 6 but the burnt-orange, later brown colonies plus somewhat boomerang shape spores indicate that this is at least a localized variant. Races 5 to 7 are similar to Rhabdospora groenlandica Lind (407), particularly race 7 from the sub-alpine Rockies.

Race 8, on Arrhenatherum elatius (type host of Phyllosticta stomaticola) from Bozeman, Montana, differs from race 2 in lesser tendency to form lavender color in agar, and in the production of dirty tan, mucose conidial masses in early stages of growth. It is close to race 6.

Race 9, on Phleum pratense, is distinct from race 1 in host range but its relation to the others is undetermined. This fungus was described by Lind (406) as Septoria culmifida Lind. However, it is morphologically indistinguishable from most of the S. donacis stomaticola complex.

Race 10, on Sporobulus asper (Michx.) Kunth, has not been cultured and little is known of its relationship with the other races. Since it has some boomerang-shape spores it somewhat resembles S. donacis but the spores are narrower.

Race 11, on rye (Secale cereale), also needs study as soon as viable material is available. The pycnidia are prominent but not large, 95-111 x 72-85 μ, and the spores are 12-18 x 2-3.5 μ, mean size 14.5 x 2.4 μ, in one collection, 16 x 2.7 μ in another. This fungus has been found in an area north of Jamestown, North Dakota, and also in Minnesota. The symptoms may be confused with those caused by bacterial leaf blight and therefore the disease on rye may be more widespread than is known at the present. It has no relation to Septoria falcispora Demidova (148) (non Bubák).

Selenophoma donacis var. stomaticola has the following host range in the various States: Agropyron albicans Scribn. and Sm. (N. Dak.); A. dasystachyum (Hook.) Scribn. (Oreg.); A. repens (Wash., N. Dak.); A. riparium Scribn. and Sm. (N. Dak.); A. smithii (N. Dak., S. Dak., Mont., Wyo.); A. spicatum (N. Dak., Wyo., Wash.); A. subsecundum (Mont.); A. trachycaulum (Mont., N. Dak.); Arrhenatherum elatius (Mont.); Calamovilfa longifolia (Hook.) Scribn. (N. Dak., S. Dak.); Dactylis glomerata (Oreg., Idaho, Wash.); Danthonia californica (Oreg.); Elymus canadensis (N. Dak.); E. giganteus Vahl (Wash.); E. glaucus (Wash., Oreg.); E. junceus Fisch. (N. Dak.); E. virginicus (N. Dak.); Festuca idahoensis (Wash.); F. ovina L. (Wash.); Hordeum brevisubulatum (Trin.) Lk. (N. Dak.); H. vulgare (Oreg.); Koeleria cristata (N. Dak., Wyo., S. Dak., Mont., Wash., Idaho); Melica harfordii Boland (Calif.); Oryzopsis hymenoides (Roem. and Schult.) Ricker (N. Dak., Mont., Calif., Oreg.); Phleum pratense (Alaska, N. Dak.); Poa alpina L. (Mont.); P. ampla Merr. (Wash., Mont., Oreg.); P. arctica R. Br. (Mont.); P. compressa

(N. Dak.); P. epilis Scribn. (Wyo.); P. interior Rydb. (Mont.); P. juncifolia (Oreg., Wash.); P. nervosa (Hook.) Vasey (Mont., Wyo.); P. pratensis (Mont., N. Dak., Wyo., Wash.); P. secunda (N. Dak., Wyo., Mont.); Puccinellia nuttalliana (Schult.) Hitchc. (N. Dak.); Secale cereale (N. Dak., Minn.); Sitanion hystrix (Nutt.) J. G. Sm. (Wash., Oreg.); Sporobolus asper (N. Dak., Mont., Iowa); S. cryptandrus (N. Dak.).

Some of these have not been given racial classification as little is known about them. The entire problem is a tremendous one, but since members of the group, with a few exceptions, are minor parasites, the need for study is not pressing. The group is almost unknown to plant pathologists although extremely common. Very often the small spherical pycnidia (frequently only 40 µ in diameter) contain but few spores, which are not easily crushed out of the pycnidia. These scattered spores when seen floating free in the mount may be easily mistaken for spores of Colletotrichum.

References: Baümler (27); Bisby et al. (49); Bubák (77); Demidova (148); Grove (296); Lind (406, 407); Lobik (411); Petrak (511); Rostrup (545); Sprague and A. G. Johnson (673, 674, 676).

SELENOPHOMA EVERHARTII (Sacc. and Syd.) Sprague and A. G. Johnson. (Septoria everhartii Sacc. and Syd.)

The pycnospores of this species are smaller than those of S. donacis var. stomaticola and in most of the material are more arcuate, being beautifully crescent-shape with sharp points. There is reason for assigning this species to the S. donacis complex because all sizes of spores are found on the various hosts from the large ones of S. donacis on Arundo to the small ones on Agrostis. In final analysis, it has been decided to separate S. everhartii from var. stomaticola, although most of our herbarium material was originally assigned to S. donacis. Sprague and A. G. Johnson (675) concluded that the S. donacis complex was sufficiently confusing without adding the small-spored group to it (676). The spores are 11-15 x 1.1-1.3 µ, sometimes 10-20 x 1-2.4 µ.

The symptoms caused by S. everhartii are similar to those produced by S. donacis. On Calamagrostis canadensis (Michx.) Beauv. the lesions are elongate, white with vinaceous to vague borders. Much of the material on Agrostis and on alpine material in semi-arid regions in general is obscure, with minute pycnidia on stramineous, dead plants. On Aristida and on Bouteloua curtipendula (Michx.) Torr. gray to tawny or paler, eye-spot lesions with vinaceous borders occur, often intermingled with saprophytic material from the preceding year.

In pure cultures on potato dextrose agar, S. everhartii shows as much racial variation as S. donacis var. stomaticola. Thus, an isolate from Agrostis scabra Willd. (Ft. Totten, North Dakota) has gray and rose

colored leathery mycelia with lavender color in the substratum. From Trisetum spicatum (L.) Richt. (Beartooth Pass, Montana), the mycelium is gray and creosote color over pale lavender; while on agar an isolate from Bouteloua curtipendula (western, North Dakota) produces a crustose off-white mycelium with no substratum color, very different in appearance from the others. A culture from Deschampsia atropurpurea (Wahl.) Scheele (also at Beartooth Pass, in Wyoming) is similar to that from T. spicatum but with gray and isabelline mycelium. On D. danthonioides (Trin.) Munro (Pullman, Washington), the mycelium was burnt-orange mixed with pink and black and with an orange substratum color, quite different from any of the others. A recent isolate from Muhlenbergia racemosa (Michx.) B. S. P. (Mandan, North Dakota) formed a black carbonaceous growth. This isolate when incubated on sterilized brome stems over winter produced small black perithecia (80-90 µ) belonging to the Mycosphaerellaceae. A few contained fascicled asci containing 8 ellipsoidal ascospores 7-9 x 2-2.6 µ. Unfortunately, it could not be determined whether these were slightly immature and only bi-guttulate (Ascospora) or somewhat more immature and ultimately one-septate (Mycosphaerella); nor could the spores be germinated.

Selenophoma everhartii occurs on the following hosts: Agrostis diegoensis Vasey (Calif.); A. scabra (N. Dak.); Aristida longiseta Steud. (N. Dak.); A. oligantha Michx. (Iowa); Bouteloua curtipendula (N. Dak.); Calamagrostis canadensis (this is the type host from Wisconsin of Septoria calamagrostidis Ell. and Ev. (non (Lib.) Sacc.) from which Septoria everhartii Sacc. and Sydow was derived); C. montanensis Scribn. (N. Dak.); C. scribneri Beal (Wyo.); Deschampsia atropurpurea (Wyo., Mont.); D. caespitosa (L.) Beauv. (Mont. and Wyo.); D. danthonioides (Wash.); D. elongata (Hook.) Munro (E. Wash.); Festuca kingii (S. Wats.) Cassidy (Mont.); F. ovina (Mont. and Wash.); F. ovina var. brachyphylla (Schult.) Piper (Wyo. Mont.); F. rubra (Mont.); Muhlenbergia cuspidata (Torr.) Rydb. (N. Dak.); M. racemosa (N. Dak.); Sphenopholis obtusata (Michx.) Scribn. (N. Dak.); Trisetum spicatum (Mont., Wyo.).

Some of the specimens that have been placed in Selenophoma everhartii may be immature stages of S. donacis var. stomaticola, in fact one reason for the long hesitation in assigning these to a separate species was the fact that fungi on Agrostis and Calamagrostis tend to be smaller on that host than the same species on some other hosts.

Selenophoma everhartii is the most common species on alpine and subalpine plants and is abundant on the dry culms of grasses in the plains country in late summer.

References: Ellis and Everhart (214); Rostrup (545); Saccardo (558); Sprague and A. G. Johnson (675, 676).

SELENOPHOMA OBTUSA Sprague and A. G. Johnson.

This fungus is a variant of the *S. donacis* complex but in most collections it is distinguishable from that group by its short, thick, almost reniform spores averaging 13-17 x 2.5-4 µ. In pure culture it is distinguishable from most of the others by prominent black pycnidial aggregates scattered in salt and pepper pattern over a light isabelline to very pale flesh background. While the spore exudate is pale lavender, the strong rosy tints of *S. donacis* and the vinaceous to lavender ones of var. *stomaticola* are less prominent. In its early stages of growth, an isolate from *Sitanion hystrix*, Mt. Shasta, California, (W. B. Cocke) produced a wet-leathery, faintly flesh color to isabelline colony. A culture isolated from *Agropyron inerme* collected at Washtucna, Washington (G. W. Fischer) showed the same type of growth in early stages, but later, mucose, tan, and still later, brown masses of spores formed over the earlier growth. This case was similar in appearance to race 6 of var. *stomaticola* and this collection may be misassigned. While typical material on *Sitanion hystrix* appears to be very distinct, other material on *Elymus glaucus* and on *S. hystrix* is variable, some close to var. *stomaticola*, others to *S. obtusa*. Certainly our *S. obtusa* is not completely separable from the whole complex.

The host range of *Selenophoma obtusa* is as follows: *Agropyron inerme* (Wash.); *Elymus condensatus* (Wash.); *E. glaucus* (Wash., Calif.); *Poa arida* Vasey (N. Dak.); *Sitanion hanseni* (Scribn.) J. G. Sm. (Calif.); *S. hystrix* (type locality is Mt. Shasta, Calif.; Mont.); *Stipa richardsoni* (Mont., Wyo.); *Stipa* sp. (Calif.). *Selenophoma obtusa* occurs throughout the range of *S. donacis* from Mandan to Mt. Shasta but is typically a fungus of the high mountains and desert. It has been collected for instance at White Bluffs, Washington, in a region having 3 inches of average annual precipitation.

References: Sprague and A. G. Johnson (675, 676).

SEPTORIA

Most of the species included here have just been the subject of a detailed study by the writer (Sprague, 665) and therefore it does not appear necessary to discuss them in detail. It is, however, believed desirable to give the following key to the species:

A. Pycnospores 0- to 2-septate, less often 3-septate

B. Pycnidia prominent, as much as 180-250 µ diameter

C. Spores filiform, 36-50 x 1.4-1.6 µ .... *Septoria poliomela* Syd.

CC. Spores obclavate filiform, 33-65 x 1.2-2.5 µ .... _S. bromi_ Sacc.

CCC. Spores obclavate, 28-50 x 2.5-4.5 µ .... _S. infuscans_ (Ell. and Ev.) Sprague

BB. Pycnidia intermediate, 100-180 µ in diameter

C. Spores filiform, 2-septate, 40-56 x 1.8-2.4 µ .... _S. elymi_ Ell. and Ev. on _Elymus canadensis_ var. _robustus_ (Scribn. and Sm.) Mackenz. and Bush

CC. Spores elongate-fusiform, 26-38 x 2-2.5 µ .... _S. spartinae_ (Trel.) Sprague

CCC. Spores elongate-fusiform, 24-42 x 2.5-4 µ, pycnidia sometimes less than 100 µ diameter .... _S. calamovilfae_ Petr.

CCCC. Spores bacillar, 1-septate, 3-septate in one Mandan, N. Dak., collection .... _S. oudemansii_ Sacc.

CCCCC. Spores filiform, faintly septate, 50-70 x 1-1.5 µ .... _S. cenchrina_ J. J. Davis

BBB. Pycnidia small, obscure, 50-120 µ diameter

C. Pycnidia typically 50-80 µ, spores 0- to 1-septate ...... _S. triseti_ Speg. em. Sprague

CC. Pycnidia typically 80-120 µ, spores 0- to 2-septate ..... _S. tenella_ Cke. and Ell.

AA. Spores typically more than 2-septate

B. Pycnospores usually less than 50 µ long

C. Spores averaging more than 2 µ wide

D. Spores bacillar

E. Spores seldom more than 30 µ long .... _S. nodorum_ Berk.

EE. Spores frequently more than 30 µ long

F. Produces a pale-colored leaf spot, spores 3-septate, 25-50 x 2.5-3.5 µ, on rye .... _S. secalis_ Prill. and Del.

FF. Produces dark brown leaf spots, spores 3-septate, 25-50 x 2.7-4.1 µ, on Lolium .... S. loligena Sprague

FFF. Produces a pale-colored leaf spot, spores 1- to 3-septate, 37-62 x 2.6-3.4 µ, on Stipa, Agrostis .... S. secalis var. stipae Sprague

FFFF. Produces a brown leaf spot, spores 3-septate, 22-38 x 2.8-3.8 µ, on Melica .... S. melicae Pass.

FFFFF. Produces a pale leaf spot, brown-bordered, spores 3- to 4-septate, 25-45 x 3-4 µ, on Avena .... S. avenae Frank

DD. Spores narrowly obclavate, apex more or less pointed

E. Pycnidia 100-140 µ, on Sporobolus .... S. andropogonis f. sporobolicola Sprague

EE. Pycnidia 75-100 µ, on Andropogon .... S. andropogonis J. J. Davis

EEE. Pycnidia 130-160 µ, on Sphenopholis .... S. andropogonis J. J. Davis

CC. Spores less than 2 µ wide

D. Pycnidia golden-brown, ellipsoid

E. Pycnophores 4-7 µ long, spores 35-40 x 1.3-1.6 µ S. macropoda Pass.

EE. Pycnophores 3-4 µ long, spores 30-50 x 1.2-2.1 µ S. elymi Ell. and Ev.

DD. Pycnidia creosote-brown, subglobose to ellipsoid, spores 14-46 x 1.3-2 µ .... S. passerinii Sacc.

BB. Spores frequently more than 50 µ long

C. Spores narrowly filiform, about 1 µ wide .... S. stipina Died.

CC. Spores more than 1 µ wide

D. Spores often more than 2.7 µ wide

E. Spores averaging less than or approximately 65 µ long

F. Spores strictly hyaline

G. Spores 2- to 4-septate, stiffly curved, obclavate-filiform, pycnophores 4-9 µ long .... (in part) S. *infuscans* (Ell. and Ev.) Sprague

GG. Spores mostly 3-septate, somewhat whip-like, obclavate-filiform, pycnophores 5-11 µ long .... S. *bromi* var. *phalaricola* Sprague

GGG. Spores 3-septate, obclavate-cylindric to narrower .... S. *agropyrina* Lob.

GGGG. Spores 3- to 5-septate, narrowly obclavate, up to 73 µ long on *Stipa comata* .... S. *andropogonis* f. *sporobolicola*

FF. Spores somewhat chlorinous .... S. *mississippiensis* Sprague

EE. Spores averaging more than 65 µ long

F. Pycnidia prominent, as much as 320 µ in diameter

G. Spores seldom more than 5-septate, lance-shape, obclavate .... S. *jaculella* Sprague

GG. Spores 3- to 7-septate, obclavate, apex elongated .... S. *arctica* Berk. and Curt.

FF. Pycnidia smaller, commonly less than 150 µ diameter

G. Pycnophores narrowly ampulliform, spores long-filiform .... S. *pacifica* Sprague

GG. Pycnophores cylindrical, spores obclavate-filiform .... S. *munroae* Ell. and Barth.

DD. Spores less than 2.7 µ wide but more than 1 µ wide

E. Pycnidia brown, cells compact, frequently elongated

F. Pycnophores awl-shape, 2-5 μ long

G. Spores very narrowly obclavate-filiform

H. On _Agrostis exarata_ .... _S. calamagrostidis_ (Lib.) Sacc.

HH. On _Koeleria cristata_ .... _S. calamagrostidis_ f. _koeleriae_ (Cocc. and Mor.) Sprague

GG. Spores filiform, less often very narrowly obclavate-filiform

H. Spores typically sinuous .... _S. calamagrostidis_ on _Agrostis palustris_

HH. Spores usually slightly curved, but less often sinuous .... _S. calamagrostidis_ on _Trisetum_ spp.

FF. Pycnophores short, papillate, 2-3 μ long ... _S. macropoda_ on _Poa howellii_ Vasey and Scribn.

EE. Pycnidia golden-brown, cells moderately compact, variable in shape, not uniformly elongated

F. Spores seldom over 1.7 μ wide .... _S. macropoda_ var. _septulata_ (Gonz. Frag.) Sprague

FF. Some spores more than 1.7 μ wide

G. Spores never 8- to 9-septate

H. Pycnophores 2- to 6 μ long .... _S. macropoda_ var. _grandis_ Sprague

HH. Pycnophores 4 to 13 μ long

I. Spores typically sinuous .... _S. tritici_ f. _avenae_ (Desm.) Sprague

II. Spores variously curved, less often sinuous

J. Microspores present, macrospores 25-90 x 1.4-2.6 µ, on wheat ....
S. tritici Rob.

JJ. Microspores not known

K. Pycnospores up to 85 µ long, on *Lolium* ....
S. tritici var. *lolicola* Sprague and A. G. Johnson

KK. Pycnospores up to 105 µ long, on *Holcus* ....
S. tritici f. *holci* Sprague

GG. Spores 3- to 9-septate, up to 95 µ long. *S. andropogonis* var. *sorghastri* H. C. Greene and Sprague

GGG. Spores usually 5-septate, up to 60 µ long ....
S. quinqueseptata Sprague

SEPTORIA AGROPYRINA Lob., Leaf Spot and Blotch.

This species is a very common but relatively unimportant component of the leaf spot complex on *Elymus* and *Agropyron* spp. in the Great Plains. Its range, however, extends west to Oregon. It apparently occurs widely in Asia and adjacent Europe. It is usually found as a saprophyte on the tips of dead or nearly dead leaves but some collections show it associated with a brown or fuscous blotch. The spores are coarse, obclavulate to sub-cylindric, and are apically pointed in most specimens. They average 40-65 x 2.5-4.0 µ and are borne in large brown pycnidia. It is difficult to distinguish this fungus from a slender phase of *Septoria infuscans* on the one hand and from *Stagonospora arenaria* Sacc. on the other. Its pointed spores more or less distinguish it from *Stagonospora arenaria*, while its development on potato dextrose agar (it forms a cottony buff colony) contrasts sharply with the scanty pellicular growth of *S. infuscans*. While typical *S. infuscans* does not appear to extend east of Yellowstone National Park, *S. agropyrina* does occur with *Stagonospora arenaria* west to Oregon.

Septoria agropyrina is readily segregated from most material of *S. elymi*, as the latter has much smaller spores and produces a yeasty colony on potato dextrose agar. There is, however, a phase of *S. elymi* that is the same as *S. elymicola* Died. which may sometimes be intermediate between typical *S. elymi* and the more slender spored collections

of S. agropyrina. This phase usually occurs on Elymus canadensis or more often on E. canadensis robustus. This phase has been seen from Iowa and North Dakota while Hardison sent us material from Michigan.

Septoria agropyrina is further briefly discussed in connection with associated forms. It should be pointed out that critical comparison with European types is needed in this group.

References: Lobik (411); Sprague (665).

SEPTORIA ANDROPOGONIS J. J. Davis, Leaf Spot.

This fungus and its various forms and variety is very common in the Great Plains region. While the species proper on Andropogon furcatus Muhl. has not been collected closer than Kansas (Lefebvre, see Sprague, 660) and Wisconsin (Davis, 139, type area), it probably occurs on this host within the area covered by this article.

Gray elongate lesions are formed with moderately prominent pycnidia more or less seriately arranged. The spores are characteristically obclavate with tapering blunt bases and narrowly sharpened apices (Sprague, 660, fig. 1, b). They are usually 3-septate, 30-51 x 2-3.9 µ, and the contents are hyaline to yellowish.

One collection on Sphenopholis obtusata from Devil's Lake, North Dakota, appears to be S. andropogonis rather than S. quinqueseptata Sprague, which also occurs on this host.

References: Davis (139); Sprague (660).

SEPTORIA ANDROPOGONIS var. SORGHASTRI H. C. Greene and Sprague, Leaf Spot.

This differs from the species in the much longer and multiseptate spores. Except for their extreme length they are fundamentally the same type of spore on a closely related genus. The first collection of this fungus on Sorghastrum nutans (L.) Nash was made by Rev. J. M. Bates, many years ago, at Long Pine, Nebraska, but the specimen was undetermined until Greene and the writer compared notes with some recently collected Wisconsin material and concluded that the fungus was only an unusual phase of S. andropogonis.

References: Greene (290); Sprague (665).

SEPTORIA ANDROPOGONIS forma SPOROBOLICOLA Sprague, Leaf Spot and Blotch.

The type of this occurs as a non-striate circular spot on Sporobolus

heterolepis A. Gray, but similar material has recently been found on Stipa comata at Mandan, North Dakota, which forms a blotch at first, later a light-colored spot. The spores of the type on Sporobolus are slightly narrower than those of Septoria andropogonis proper, while those on Stipa are somewhat longer (40-73 x 2.4-3.4 µ), but also proportionately slightly narrower. This character, plus the somewhat larger, light-colored pycnidia in f. sporobolicola, readily segregates the form from the species. Except for these differences they all belong in the one species. At present f. sporobolicola is confined to the Agrostidae; while the species proper and its var. sorghastri occur on the Andropogoneae except for the Devil's Lake collection on Sphenopholis of the Aveneae. The possibly related species S. quinqueseptata also occurs on Sphenopholis, while another related but we believe distinct species, S. mississippiensis, occurs on Muhlenbergia of the Agrostideae. It would appear that this group has adapted itself to a considerable range of tribes under the favorable conditions of association in the plains country. Since much of this information has been obtained only recently it is expected that further forms will be noted.

Forma sporobolicola was recently identified also on Stipa viridula from South Dakota. It is likely much more common than collections indicate, as much of the material on Stipa is not fruiting.

References: Sprague (660, 665).

SEPTORIA ARCTICA Berk. and Curt., Leaf Spot.

The type of this species was collected on Dupontia fischeri R. Br., on an island off the Siberian coast in the Bering Straits. It occurs also on Calamagrostis nutkaensis near Seaside, Oregon, and apparently in southern Alaska and northern Europe (Sprague, 665). The spots are ill-defined brown to dull gray lesions; pycnidia are large (140-250 µ); spores are hyaline obclavate-scolecosporous with tapering rounded bases and sharply pointed apices. The spores in the type are 2- to 3-septate or more, 60-80 x 2.8-3.6 µ, straight to stiffly curved, and somewhat resemble spores of S. jaculella Sprague on Bromus spp. On C. nutkaensis, the spores are 3- to 7-septate, 70-89 x 3.5-4.6 µ. It is suspected that this species is more widespread and abundant than collections indicate. It appears to be distinctly parasitic.

References: Berkeley and Curtis (42); Sprague (665).

SEPTORIA AVENAE Frank, Speckled Blotch of Oats.
(Ascigerous stage, Leptosphaeria avenaria G. F. Weber)

A collection on some late-seeded green-manure oats on the Northern Great Plains Field Station, Mandan, North Dakota, represents the only

collection of this fungus from the western area, although it is common in Wisconsin and northward and is also probably present in Minnesota.

The 3-septate bacillar spores of this fungus are close to *Stagonospora*. Since the perithecial stage is known (Weber, 752), the fungus can be referred to that stage and the questionable status of the imperfect stage is not so important as if its perithecial stage were unknown. Routine workers will recognize the pycnidial stage as a *Septoria*, although it is probably closer to the narrow-spore *Stagonospora* forms that produce cottony mycelium from germinating spores on potato dextrose agar, as contrasted with the slimy yeasty (mucose) conidial masses that most grass-inhabiting species of *Septoria* form under the same conditions.

References: Frank (237); Weber (752).

SEPTORIA BROMI Sacc., Leaf Spot.

Lesions on brome grasses are obscure, sometimes evident as elongate or elliptical spots, but often the infected leaves turn yellow, then dry up and become brown. The pycnidia are only moderately prominent, 60-240 μ, black-brown, and the spores are characteristically whip-like, usually 2-septate, 33-65 x 1.2-2.5 μ, or sometimes stouter in Oregon material, but not to be confused with the javelin-like spores of *S. jaculella*. The host range includes: *Bromus commutatus* Schrad. (Oreg., Idaho); *B. inermis* (Mandan, N. Dak., Oreg., Wash.); *B. japonicus* Thurb. (Wash., Wyo.); *B. mollis* (Oreg., Wash.); *B. racemosus* L. (Oreg.); and *B. secalinus* L. (Oreg., Idaho, Iowa). This fungus is seldom serious in the West.

References: Sprague (665); Weber (754).

SEPTORIA BROMI var. PHALARICOLA Sprague, Buff Spot.

This fungus occurs in buff lesions on the leaves of reed canary grass at Astoria, Oregon. The spores are obclavate-filiform, 3-septate instead of 2-septate as in *S. bromi*, 37-66 x 1.7-2.9 μ, borne in large pycnidia 150-180 x 204-276 μ. This species may be distinguished from certain other pycnidium-bearing leaf spots of reed canary grass as follows:

A. Spots pale with narrow fuscous or tinted border, spores non-septate, falcate ....
Selenophoma donacis (Pass.) Sprague and A. G. Johnson

AA. Spots buff, yellow, or obsolete

B. Spots pale or absent, spores 0- to 1-septate, falcate, from the Argentine ....
Septoria macrostoma Speg. (Sprague, 665, fig. 19, c)

BB. Spots buff

C. Spores 1-septate, hyaline, 20-25 x 1.3 μ, from Italy ..
Septoria phalaridis Cocc. and Mor. (120)

CC. Spores 3-septate, hyaline, obclavate-filiform, from Oregon and probably Italy ....
Septoria bromi var. phalaricola Sprague (665)

BBB. Spots tawny blotches, spores 38-71 x 4.5-6.0 μ (when mature), 3- to 8-septate (3-septate phase 25-40 x 2.7-4.5 μ), from Middle West and the Great Plains and in Europe ....
Stagonospora foliicola (Bres.) Bub. (See under Stagonospora below)

SEPTORIA BROMI var. PHALARIDIS Trail (Trail 709) is PHAEOSEPTORIA PHALARIDIS (Trail) Sprague (Sprague 659)

References: Cocconi and Morini (120); Saccardo (554); Sprague (659, 665); Trail (709)

SEPTORIA CALAMAGROSTIDIS (Lib.) Sacc., Leaf Spot.

The lesions are gray to straw color, usually not abundant, and occur most commonly during late winter or early spring in Oregon. The pycnidia are strongly flattened, dark brown, 50-140 x 50-180 μ in lateral diameter and 50-80 μ vertically, and are characteristically formed of compactly intertwined cells 1.7 μ in diameter. The spores are filiform, 0- to 5- septate, 25-71 x 1.0-2.0 μ, often sinuous. The host range of this species is as follows: Agrostis diegoensis Vasey (Oreg.); A. exarata (Oreg., Alaska); Trisetum canescens Buckl. (Oreg.); T. cernuum Trin. (Oreg.). The fungus on Trisetum usually has stiffer straighter spores than on Agrostis but one collection on T. canescens from Douglas County, Oregon, has spores identical with those on Agrostis. This form on Trisetum is confined to species of that genus on which it is very parasitic. It is considered to be only a race of S. calamagrostidis. Such species as S. caballeroi Gonz. Frag. (270), S. caballeroi var. panicei Gonz. Frag. (272), and S. graminum f. triseti-loeflingianii Cab. (88) are synonyms.

Our studies indicate that material on Agrostis palustris may be called race 1, on A. exarata, race 2; and on Trisetum spp., race 3.

Other fungi that may be confused are the shorter-spored Septoria triseti (common on A. tenuis but not on A. palustris, the reverse of the situation with S. calamagrostidis), and the bacillar spored S. secalis var. stipae which sometimes occurs on Agrostis.

References: Anderson (11); Caballero (88); Cocconi and Morini (120); Gonzalez Fragoso (270, 272); Saccardo, Peck, and Trelease (559); Sprague (642, 665)

SEPTORIA CALAMAGROSTIDIS (Lib.) Sacc. f. KOELERIAE (Cocc. and Mor.) Sprague, Leaf Spot. (S. koeleriae Cocc. and Mor.)

This fungus differs from S. calamagrostidis in its stiff needle-like spores, 35-60 x 1.1-2 µ, that are readily distinguishable from the species proper. It is confined to Koeleria.

Septoria calamagrostidis f. koeleriae occurs from North Dakota to Oregon and Washington. The fuscous spots are relatively abundant in spring on Koeleria cristata in the eastern and mountainous parts of Oregon and Washington.

References: Cocconi and Morini (119); Sprague (665).

SEPTORIA CALAMOVILFAE Petr., Leaf Spot.

The type locality of this species is Kulm, North Dakota, where it occurs on Calamovilfa longifolia (Hook.) Scribn. The writer has found it at Faith, South Dakota, and near Colony, Wyoming. The spores are smoky-hyaline, spindle-shape, 24-42 x 2.5-3.7 µ, 0- to 2-, sometimes 3-septate. It causes a white or pale gray spot on the leaves and sheaths.

Reference: Petrak (510, p. 86).

SEPTORIA CENCHRINA J. J. Davis, Leaf Spot.

Reported on Cenchrus pauciflorus Benth. from Minnesota as well as from the type area at Spring Green, Wisconsin. This species has filiform, continuous or faintly septate spores, 30-100 x 1.5-3.0 µ, borne in proportionately small pycnidia, 60-115 µ. The longer spores (Davis, 142) protrude through the wide ostiole.

References: Davis (142, p. 296).

SEPTORIA ELYMI Ell. and Ev., Speckled Leaf Blotch
(Septoria agropyri Ell. and Ev.)

This fungus causes pale gray to tan or fuscous lesions which, with the numerous pycnidia, produce the effect of speckled blotch. The spores are smaller than those of S. tritici, 25-50 x 1.2-2.1 µ, 0- to 3-septate. A form of this fungus on Elymus canadensis var. robustus in Iowa, Wisconsin, and Michigan has 2-septate larger spores, 40-56 x 1.8-2.4 µ. The form on Agropyron spp. (Ellis and Everhart, 213) has spores too nearly like those of S. elymi Ell. and Ev. (212) to be worthy of recognition as a separate species, therefore S. agropyri Ell. and Ev. (214) is considered a synonym of S. elymi. The host range also is partly interchangeable.

The host range of Septoria elymi is as follows: Agropyron inerme (Oreg.); A. repens (Oreg., Wash., Mont., N. Dak., Minn., Iowa, Nebr.); A. smithii (N. Dak., S. Dak.); A. spicatum (Wash., Wyo.); A. subsecundum (Mont., N. Dak.); A. trachycaulum (N. Dak.); Elymus canadensis (N. Dak., S. Dak., Minn.); E. canadensis var. robustus (Iowa); E. glaucus (Oreg., Wash.); E. triticoides (Calif.)

S. elymi is readily distinguished by its smaller spores from S. infuscans, S. pacifica, Stagonospora arenaria, and Septoria agropyrina, all of which occur on Elymus and Agropyron.

References: Ellis and Everhart (212-214); Sprague (665); Weber (754).

SEPTORIA INFUSCANS (Ell. and Ev.) Sprague, Brown Leaf Blotch.
(Cylindrosporium infuscans Ell. and Ev.)

Elymus condensatus and sometimes E. glaucus (Oregon and Washington), Agropyron spicatum (Oregon), and Elymus triticoides (Oregon, California) are heavily blotched by this fungus in the western States as far east as Yellowstone National Park, Wyoming. The type material and much of that from the Columbia Basin of Oregon and Washington has obclavulate, blunt-base pycnospores tapering to a stubby point at the apex; 1- to 3-septate, 28-50 x 2.5-4.5 µ (Cooke, 126, no. 113). However, some material, particularly that on E. triticoides, has obclavulate-filiform spores 1- to 4-septate, 40-75 x 1.7-2.7 µ, resembling those of S. elymi-europaei Jaap. In pure culture, both kinds produce small gray pellicular colonies with imbedded pycnidia. One isolate of a narrower form from E. condensatus, Washtucna, Washington, produced an off-white mucose growth that spread somewhat more rapidly than most of the isolates, and this may be different.

East of the range of S. infuscans, a large spored fungus in white stramineous or fuscous lesions occurs on Elymus and Agropyron. This is referable to S. agropyrina Lob. (non Unamuno, 731). It produces a buff

cottony growth, similar to Stagonospora arenaria Sacc., in pure culture.

S. infuscans frequently has microspores, 5-7 x 1-1.5 µ, narrowly ovate, short cylindric, often curved.

References: Cooke, W. B. (126, No. 113); Ellis and Everhart (216); Jaap (357); Sprague (649, 665); Unamuno (731).

SEPTORIA JACULELLA Sprague, Western Brome Speckle.

This fungus has been known for only a few years, but it occurs on a leaf of Bromus carinatus collected by David Douglas in 1832, probably from southern Oregon. The fungus invades living tissue very slowly so that the lesions are vague, mottled or blotched, partly owing to the fact that green, brown, and yellow tissues are intermingled with mature pycnidia. Sometimes streaks of dead tissue are formed.

The pycnidia are large; the diamond blue hyaline spores are stiffly javelin or lance-shaped, 45-90 x 1.9-4.0 µ, with numerous microspores present in some collections. Efforts to obtain the fungus in pure culture have been negative; the spores will germinate on potato dextrose agar, but they soon die.

The host range is as follows: Bromus carinatus (Oreg., Wash; Trude, Idaho); B. ciliatus L. (Bradshaw Mts., Ariz.); B. laevipes Shear (Calif.) B. rigidus Roth (Oreg., Wash.), and B. tectorum (Wash.).

References: Cooke (127, no. 114); Sprague (650, 665).

SEPTORIA LOLIGENA Sprague, Brown Leaf Spot.
(S. lolii (Cast.) Sacc.)

Causes a deep chocolate-brown leaf spot surrounded by lighter areas. The spores are bacillar, clear hyaline, 3-septate, 28-45 x 2.7-4.2 µ, and are therefore similar to those of S. secalis or to S. avenae and not to those of S. tritici var. lolicola, which has much narrower spores.

Besides the original material from France, this fungus occurs in California on Lolium multiflorum. It was collected in the San Francisco area by W. B. Cooke recently (Sprague, 665).

References: Castagne (98); Sprague (665).

SEPTORIA MACROPODA Pass., Leaf Blotch.
(Septoria annua Ell. and Ev., S. poae-annuae Bres.)

The common leaf blotch on Poa annua and on P. kelloggii Vasey (Oregon),

P. howellii (Oregon), and P. nervosa is abundant in the northern United States wherever the hosts occur and humid conditions prevail during the growing season. It is obtainable any month of the year in coastal Oregon but is particularly prevalent in late winter. The spores are very slender, 30-40 x 1-1.5 µ.

References: Bresadola (67); Cocconi (59); Ellis and Everhart (215); Gilman and Archer (262); Sprague (665).

SEPTORIA MACROPODA var. GRANDIS Sprague, Leaf Blotch.

The spores of this variety are larger than those of S. macropoda, some of them approaching Septoria tritici, 40-70 x 1.5-2.4 µ. It occurs in the interior of the United States from the Cascade Mountains in Oregon, Washington, and California to the center of North Dakota. The host range of this variety is as follows: Poa ampla (Wash.); P. arida (Faith, S. Dak.); P. canbyi (Mont.); P. cusickii Vasey (Mont.); P. nevadensis Vasey (Oreg., Calif.); P. pratensis (Wyo.); P. scabrella (Thurb.) Benth. (Wash.); P. secunda (Oreg., Wash., S. Dak., Wyo., Mont., N. Dak.); P. vaseyochloa (Wash.). The collection on P. pratensis was more or less accidental; the common form on that host is var. septulata to be discussed later. Septoria macropoda var. grandis is very widespread in the high range country in the very early spring and has been collected as early as December in Klickitat County, Washington. As soon as the weather warms up and becomes dry in Oregon and Washington the spots lose their identity and are difficult to see. Some racial differences were noted in this variety.

References: Sprague (656, 665).

SEPTORIA MACROPODA var. SEPTULATA (Gonz. Frag.) Sprague, Leaf Blotch.
(S. poae-annuae var. septulata Gonz. Frag.)

Septoria macropoda var. septulata is cosmopolitan throughout the northern United States as the cause of a dark gray or brown spot irregular in shape on the leaves of Poa pratensis. It is readily recognizable from the species by its needle-like spores, which are 40-60 x 1.3-1.7 µ and are narrower than those of var. grandis. While these forms are similar enough to be placed in one species, they are sufficiently distinct from each other both morphologically and ecologically to be recognized as subdivisions. The var. septulata also occurs on Poa compressa and on P. nervosa.

References: Gonzalez Fragoso (273, 274); Sprague (657, 665); Weber (754).

SEPTORIA MELICAE Pass., Leaf Blotch.

This fungus was found in the grass nursery at the Northern Great Plains Field Station, Mandan, North Dakota, in August 1943. It caused a brown leaf spot on Melica scabrosa Trin. This is another of the complex of closely related species with 3-septate bacillar spores, in this case, 22-38 x 2.8-3.8 µ. It is slightly less robust appearing than S. avenae. There is no report on this fungus for North America except that Schizachne purpurascens (Torr.) Swallen is listed as a host in Seymour's list (599). The writer (666) mentions it in a recent article.

SEPTORIA MISSISSIPPIENSIS Sprague, Leaf Spot.

This fungus causes a buff eyespot with prominent brown borders on Muhlenbergia mexicana (L.) Trin. in Minnesota and on M. asperifolia (Nees and Mey.) Parodi in North Dakota. The spores are like those of S. andropogonis (see also Karsten, 378, on S. bromi var. alopecuri Karst.) except that they are chlorine yellow instead of hyaline to faintly yellow, and the contents appear much different as can be readily seen by comparing the two species (Sprague, 660, fig. 1, a,b,c). S. mississippiensis does not appear to be very abundant.

References: Karsten (378); Sprague (660, 665).

SEPTORIA MUNROAE Ell. and Barth, Leaf Spot.

The lesions on Munroa squarrosa (Nutt.) Torr. in Kansas and Colorado are straw color and obscure but the seriately arranged pycnidia are abundant. Spores are 80-110 x 2.5-3.0 µ and resemble certain species of Cercospora. This species has not been studied to any extent.

References: Ellis and Bartholomew (208); Sprague (665).

SEPTORIA NODORUM Berk., Glume Blotch.

Typical spores of the fungus causing glume blotch of wheat are short, cylindrical, 0- to 3-septate, 15-30 x 2.3 µ. This species is widely known in Europe and in the northern United States and Canada on wheat and wheat relatives as a leaf spot and later, towards harvest, as a blotch on the glumes of the maturing heads and on culm parts, particularly the nodes. In Germany, the fungus is often known as Macrophoma hennebergii (Kuehn) Berl. and Vogl. (43) or sometimes by the earlier name of Phoma hennebergii Kuehn (393). Petrak and Sydow (512) placed it in Stagonospora hennebergii (Kuehn) Petr. and Syd. A study of material from Germany, from North Dakota, and from adjacent regions shows that true S. nodorum is associated with forms that have somewhat larger spores, 25-45 x 2.5-4.3 µ. In addition material on Elymus and

Agropyron is confused with Septoria agropyrina Lob. but in the latter the apical end of the longer spores tends to be somewhat pointed and less cylindrical. Just where Stagonospora arenaria Sacc. ends and S. nodorum begins in some of the collections is also an open question. In fact there is some question as to whether S. nodorum is not a species of Stagonospora, as pointed out by Petrak and Sydow (512).

After segregating what appears to be Septoria agropyrina and Stagonospora arenaria from Septoria nodorum, the host range of the latter is as follows: Agropyron repens (N. Dak.); A. trachycaulum (N. Dak.); Elymus excelsus Turcz. (N. Dak.); E. sibiricus L. (N. Dak.); Glyceria elata (Nash) Hitchc. (Cornucopia, Oreg.); G. pauciflora Presl (Cascade Mts., Wash.); G. striata (Lam.) Hitchc. (Hoover, Oreg.); Hystrix patula (Minn.); Poa palustris (Rough Lock Falls, S. Dak.); Poa pratensis (Oreg.); Triticum aestivum L. (wheat) (Mont., N. Dak., S. Dak., Nebr., Minn., Iowa); T. spelta L. (Alsea Valley, Oreg.); Stipa viridula (Mandan, N. Dak.); T. dicoccum Schrank (N. Dak.).

The collections on Glyceria represent a fungus that may warrant separation from Septoria nodorum. The spots are large, buff, later paler, and the spores appear narrower than typical S. nodorum. The apices are somewhat pointed but the spore shape is more slender and not at all like that of S. agropyrina, which is a much coarser fungus. The writer (638) referred the first collection, from Hoover, Oregon, to Stagonospora glyceriae Roum. and Fautr., but better material has since shown that this was incorrect. Host range studies are needed with this species or form to determine its relationship to the group.

Septoria nodorum produces a buff or light-colored cottony mycelium in potato-dextrose agar and superficially resembles isolates of Stagonospora arenaria and of most of the other bacillar-spored forms. In producing a cottony growth, it differs fundamentally from the true Septoria group with filiform spores, which mainly produce masses of mucose conidia in pure culture from germinating spores.

References: Alfaro (6); Berkeley (41); Berlese and Voglino (43); Bockmann (53); Diedicke (167); Grove (295,296); Kuehn (393); Luchetti (412); Machacek (419); Passerini (503); Petrak and Sydow (512); Rosen (544); Sprague (665); Sydow (695).

SEPTORIA OUDEMANSII Sacc., Leaf Spot.

Light purple, finally straw color lesions occur on Poa pratensis and P. compressa during wet weather in Oregon and Washington. The lesions on these hosts and on P. canbyi, P. secunda, P. juncifolia, and P. nevadensis from the Rocky Mountains and the Northern Great Plains are obscure, sometimes vague blotches, more often faded to neutral straw color. The disease is not important, although it was severe at Mandan in August 1943. In western Oregon and Washington it occurs during the

rainy period in winter and early spring. Griffith (293) indicates that the disease is important on Poa pratensis leaves in Kentucky during the cool, wet season. Seymour (599) lists S. oudemansii on Poa flexuosa var. elongata Blytt and on Hierochloë alpina (Sw.) Roem. and Schult., probably from northeast America. The first record from this country appears to be a collection made by the writer in Klickitat County, Washington, in February 1935, although he had the fungus in pure culture as early as 1932 but did not determine its identity until later. In 1935, he reported it on Poa pratensis in two places in western Oregon as Ascochyta sp. (Sprague, 629) and in 1942 corrected this to Septoria oudemansii Sacc. (Sprague, 655, 656). He also found it in material sent to him from Michigan for determination (Hardison, 310). Host range additions were noted by the writer in 1942 (Fischer, et al., 231). The fungus therefore appears to be firmly established in literature as a recognized parasite of bluegrasses in the northern United States.

In first classifying the fungus as a species of Ascochyta, the writer (629) placed the fungus where its most common spore phase should be placed. In all but one collection of several dozen seen, the spores are 12-24 x 1.7-2.8 µ, cylindrical but typically slightly thicker at the central septum. Microspores range from 4 x 2 µ up to typical Ascochyta macrospores. That this Ascochyta is potentially a species of Septoria is shown by one collection made at Mandan in rainy weather in August, 1943. The spores are 3-septate, 35-55 x 3-4 µ, mingled with spores 11-18 x 2.5 µ. In pure culture they are identical. Therefore, S. oudemansii is left in Septoria even though its common spore condition is that of a slender Ascochyta phase.

References: Allescher (7); Fischer, et al. (231); Griffith (293); Hardison (310); Seymour (599); Sprague (629, 655, 656, 665).

SEPTORIA PACIFICA Sprague, Leaf Blotch.

The spots are fuscous, soon straw color, the pycnidia prominent and seriately arranged. The spores are very slender, 1- to 8-septate, 60-110 x 1.5-3.5 µ, and therefore are too long and narrow for any phase of S. infuscans or of Stagonospora arenaria. Septoria pacifica is found on coarse beach grass, Elymus mollis Trin., along the seashore in Oregon and also on E. condensatus var. pubens Piper in central California (H. W. Johnson). A stray isolate of apparently the same species was obtained from E. glaucus in plots at Mandan, North Dakota.

The fungus produces a pale caenstone color colony, which eventually becomes covered with small-mounded, black, stromatic tissue which exudes white spore masses. The colonies, except for the color of the spore exudate, resemble the common form of S. infuscans.

Reference: Sprague (665).

SEPTORIA PASSERINII Sacc., Leaf Blotch.

Fuscous, somewhat indefinite lesions are formed on barley and related grasses. The leaves later turn yellow, then brown after death. The pycnidia are only moderately conspicuous against the strongly fuscous lesions. The pycnidia are creosote-brown, mostly subglobose, scarcely erumpent, 90-140 µ in diameter and up to 100 µ deep. The walls are relatively thin, 5 to 10 µ, composed of strongly pigmented cells and an inner layer of polyhedral cells. The pycnophores are somewhat filiform to subulate, 3.4-5 x 1.2-1.8 µ. The pycnospores are of two kinds: (1) Macrospores which are broadly filiform, obtusely pointed at both ends, rarely curved, 1- sometimes 3-septate, 22-44 x 1.5-2.2 µ; but saprophytic material on Hordeum nodosum from Sydney, Montana, had spores 45-70 x 1.8-2.4 µ, although typical material on the same host in the same general locality had spores 30-45 x 1.6-2.0 µ. Material on Sitanion hystrix from Mt. Hood, Oregon, had narrowly obclavate to nearly filiform spores 14-46 x 1.3-2.0 µ (mostly 40 x 1.4 µ). (2) Microspores, which are much smaller, bacteria-like, 3-6 x 0.3-0.6 µ, but occur in typical pycnidia of the species. Microspores are common on H. nodosum in Oregon and have been noted on Hordeum distichon L. from the Kiev District, Russia.

Septoria microspora Ell. on Hystrix patula (Indiana) has spores 9-12 x 0.7-1.2 µ (Ellis, 207) and is likely only a microspore stage of S. passerinii. Recently macrospores referrable to S. passerinii were found on Hystrix patula at Cotton Lake, Minnesota. (Sprague, 669).

S. passerinii is rare on cultivated barley (Hordeum vulgare) in the far West but is common on Hordeum nodosum in Oregon, Washington, Wyoming, and Montana, and is very prevalent on Hordeum jubatum in the Dakotas. From observations made in eastern South Dakota and from the earlier collections of A. G. Johnson (368) it is apparent that barley is commonly parasitized by this fungus in the area.

References: Ellis (207); A. G. Johnson (368); Passerinii (505); Saccardo and Trotter (560); Sprague (665); Weber (754).

SEPTORIA POLIOMELA Syd., Leaf Spot.

Forms gray to straw color spots on the sides and tips of the leaves of Deschampsia caespitosa (western Oregon) and tan to straw color lesions on the lower leaves of D. danthonioides in Oregon and Washington (Sprague, 655, 656). The spores are clear hyaline, strongly curved, 36-50 x 1.4-1.6 µ, 0- to 2-septate on D. danthonioides. On D. caespitosa the spores are 1- to 3-septate, needle-like, tapering towards each end or slightly blunt at one end, 33-47 x 1.5-2.0 µ, mostly about 40 x 1.8 µ. In the type collection on Aira caryophyllea L. from Madeira (Sydow, 694) the spores were 15-30 (50) x 1.5-2.5 µ (Sprague, 665, fig. 13,b), mostly 20-30 x 1.5-2.2 µ. The same fungus probably occurs in Morocco

(Maire and Werner, 429).

The fungus produced a white to pale cream color, slow growing mounded yeasty colony on potato dextrose agar which soon became covered with a short-nap, velvety, gray mycelium, similar to S. elymi (Sprague, 665).

References: Maire and Werner (429); Sprague (655, 656, 665); Sydow (694).

SEPTORIA QUINQUESEPTATA Sprague, Leaf Spot.

The type specimen from Mandan, North Dakota, occurs on Sphenopholis obtusata (665). The spores are uniformly filiform, 5-septate with obtuse bases and sub-acute apices, 48-58 x 1.9-2.4 µ, borne in pycnidia with small ostioles, 98-115 µ, on saprophytic, straw color material without any spotting.

Since the species was described, another collection on this host has been made near Devil's Lake, North Dakota, which seems to be Septoria andropogonis. The spores are 30-38 x 2.3-3.8 µ, mostly 2.8 µ wide. The pycnidia are 130-160 µ in diameter, which is atypical for most material of S. andropogonis (but see f. sporobolicola). The spots are small linear, white, finally fading to straw color. S. quinqueseptata occurs also on Koeleria cristata at Mandan, North Dakota (666). Further study may show that S. quinqueseptata is a form of S. andropogonis, which is becoming recognized as a somewhat polymorphic species on a wide range of hosts.

References: Sprague (665, 666).

SEPTORIA SECALIS Prill. and Del., Leaf Blotch.

The lesions on rye (Secale cereale L.) are yellow brown, the pycnidia are brown with walls of thick layers of light brown, rectangular cells, which give rise to creeping hyphae terminating in prominent subulate to almost fusiform pycnophores. These pycnophores are frequently bent or semi-sinuous and 5.5-8 x 1.9-2.2 µ (Sprague, 665). The spores are hyaline, 3-septate, narrowly cylindrical, 25-50 x 2.0-3.5 µ, mostly 35 x 2.7 µ and therefore slightly longer than the bare minimum of length to width ratio (10 to 1) permitted in Septoria. The microspore stage has spores about 10 x 0.5 µ and has been described as Phoma secalina Jancz. (S. secalina (Jancz.) Sacc.). S. secalis occurs in Iowa and has been collected near Washington, D. C. It was abundant in Minnesota, North Dakota, and South Dakota in 1944 as far west as Mandan. It was not serious in any fields that were examined. This species has not been found on rye in the Far West.

References: Janczewski (360); Sprague (665); Weber (754).

SEPTORIA SECALIS var. STIPAE Sprague, White Leaf Spot.

The lesions eventually become white or finally stramineous. The variety has spores 37-50 x 2.6-3.1 μ, appearing not only longer but also slimmer than the species proper on rye. The pycnidia are globose, 130-190 μ, with an erumpent ostiole which is somewhat more prominent than in the species. The variety is common on Stipa viridula in the Northern Great Plains and a similar fungus occurs on Agrostis scabra in the same region. The summer material on Stipa is often 1-septate and somewhat larger and proportionately more slender than Septoria nodorum but confusable at times. S. nodorum occurs on Stipa viridula in the region also. The same one-celled phase occurs in Oregon on Agrostis hallii. Also, one collection on Stipa williamsii Scribn. in plots at Mandan, North Dakota, had 1-septate spores only, 21-31 x 2.8-3.8 μ, and with microspores 5-10 x 0.5-0.7 μ.

Cross inoculation studies are needed to determine the host range of this variety and its relation to the species. In fact, a critical study is needed of the bacillar-spored group, including Septoria avenae, S. secalis, S. nodorum, S. melicae, S. loligena, and others, to determine whether some of them are not taxonomically unnecessary. In the writer's earlier investigations (665), this group was not available for adequate host range studies.

Septoria andropogonis f. sporobolicola, which occurred abundantly on Stipa comata at Mandan in 1944 has pointed, proportionately more slender spores.

References: Sprague (652, 665, 666).

SEPTORIA SPARTINAE (Trel.) Sprague, Leaf Spot.

Spots on the living leaves are elliptical to striate, straw to buff color, with obscure, tardily erumpent pycnidia 100 to 140 μ wide and 70 to 90 μ deep, deeply immersed, black, heavy walled, darker around the ostiole. The pycnophores are prominent, cuspidate to narrowly pyriform, arising from hyaline pycnophore initials along the floor of the pycnidium. The pycnidia are somewhat "Rhabdospora-like", that is, dark and heavy-walled, because they are buried in the silicified, thick leaves of the host. The hyaline, mostly 2-septate spores of material from Utah, are narrowly elongate-fusiform, tapering to a relatively sharp apex and a more gradually blunted or truncate base, 26-38 x 2.0-2.5 μ. Material from Wisconsin has spores that range up to 3.0 μ wide. Septoria spartinae occurs on Spartina gracilis Trin. (Utah) and on S. pectinata Lk. (S. Dak., Wis.). While it was originally described by Trelease (1885) as a species of Ascochyta, it is obviously closer to Septoria.

References: Davis (140); Sprague (665); Trelease (710, p. 121; p. 17

of reprint).

SEPTORIA STIPINA Died., Leaf Spot.

The lesions on the dead necrotic leaves of Stipa columbiana var. nelsoni (Scribn.) Hitchc. in eastern Oregon are vague and the material scanty. The pycnidia are prominent, dark brown, erumpent, ostiolate, finally collapsed, 100-120 x 150-200 µ, composed of compacted, creosote-brown crushed cells. The spores are straight, very narrow, 1- to 4- (mostly 3-) septate, 39-63 x 0.8-1.1 µ (average 52 x 0.95 µ)(Sprague, 665). The only specimen seen in the United States is this fragmentary one from the Blue Mountains of Oregon. It appears to be closer to S. stipina than any other fungus encountered. S. stipina was described from material gathered at Kashmir, India, on Stipa sp. (Sydow and Butler, 696). It has dilute brown pycnidia, 90-120 µ in diameter, with prominent ostioles and filiform, curved to flexuous, hyaline spores 25-40 x 0.5 µ. The Oregon material therefore has longer, stiffer spores borne in larger pycnidia. Other species to consider are: S. stipae Died. (167), which, by virtue of priority became S. capillatae Trott. (Sacc. 558 v. 25, p. 430.), but Grove (296) indicated that S. stipae Died. had irregularly bent spores allied to S. lunata Grove and is therefore likely a species of Selenophoma in the Sel. donacis var. stomaticola complex. S. stipae Trabut (707) has superficial pycnidia and may be a species of an aseptate-spored Septoriopsis Gonz. Frag. (271).

References: Diedicke (167); Gonzalez Fragoso (271); Grove (296); Sprague (665); Sydow and Butler (696).

SEPTORIA TENELLA Cke. and Ell., Leaf Blotch.

Small, vague, gray to greasy brown spots form on the filiform leaves of the fescues. On some hosts, the lesions are stramineous and indefinite. The pycnidia are creosote-brown, 60-120 x 95-130 µ, more or less elliptical in cross section, composed of tightly crushed, oblong to polyhedral cells averaging 0.5 to 3.0 µ wide (or rarely more). The pycnophores are characteristically cylindrical, or very narrowly subulate, averaging 1 µ wide and up to 4 µ long. Sometimes the hyphae are scarcely different from the small globose to angular pycnophore initials. This species is characterized by the small size of the cells composing the pycnidial wall and by the small size of the pycnophores (Sprague, 665, fig. 12, e, k). The pycnospores of S. tenella are exceedingly variable, 5-70 x 0.8-2.1 µ, but most commonly they are filiform, somewhat curved, 0- to 2-septate and 25-45 x 1-1.5 µ (Sprague 665, fig. 12).

Spores on Festuca dertonensis from western Oregon vary from 28-41 x 0.8-1.2 µ to 7-17 x 1.0-1.5 µ and even 9-12 x 1.4-1.7 µ in adjacent

pycnidia, while on F. rubra var. commutata all spore types are intermingled and found to some extent in the same pycnidium. The most common material and the most widespread occurs on F. octoflora Walt. from Idaho to Minnesota, with spores 0- to 2-septate, 44-67 x 1.6-2.1 µ. In May 1941, this fungus caused a speckled lesion on the basal leaves and culms of almost 100 percent of this grass over vast areas in the Dakotas. It was at that time the most abundant parasite on any grass in the region.

Material on F. rubra commutata from Oregon appears to be a variant similar to Septoria festucae Died. However, the material on F. dertonensis could be assigned to S. tenella, S. festucae, or Ascochyta sp., depending on the particular pycnidium examined. The material from the Great Plains is more typically and uniformly like S. tenella. It is no doubt racially distinct from the polymorphic West Coast material. S. tenella also occurs on F. ovina in the Yellowstone Park.

In pure culture, the isolates from F. rubra commutata produced a peculiar slimy cocoa brown mass of conidia, which contained many Ascochyta-like spores and also filiform spores plus many variants or freaks. Later the conidial masses, through germination of the spores, produced a somewhat carbonized surface to the colony. The isolations from near Grassy Butte, North Dakota, from F. octoflora were different in that mucose mounded, flesh pink colonies similar to Septoria tritici were formed.

A collection of a species of Phyllosticta on F. subulata had spores 4.5-11 x 1.4-2.0 µ and was assigned as being close to Septoria tenella but possibly different (Sprague, 665).

References: Cooke and Ellis (125); Diedicke (165); Sprague (665); Tehon and Daniels (701).

SEPTORIA TRISETI Speg. em. Sprague, Leaf Mottle.

This fungus that causes a spot on Agrostis tenuis is commoner than the larger spored fungus S. calamagrostidis, which does not attack A. tenuis but is common on A. palustris. S. triseti also occurs on A. alba, A. exarata, and A. castellana Boiss. and Reut. in Oregon. S. triseti causes gray, later fuscous or brown spots, and the spots are more abundant and larger than those caused by S. calamagrostidis. The spores are 18-43 x 1.1-2.0 µ, 0- to 1-septate. It is confined, as far as known, to western Oregon and Washington in the United States.

References: Spegazzini (619); Sprague (665).

SEPTORIA TRITICI Rob., Speckled Leaf Blotch.

Septoria tritici causes a gray speckled blotch on the leaves of wheat and other Triticum spp. The numerous pycnidia are golden brown, substomatal, ostiolate, usually distinctly flattened, ellipsoid, 60 to 200 µ in diameter, averaging usually 100 to 150 µ. The thin walls are composed of 2 to 5 outer layers of golden brown, oblong, box-shape, thin-walled cells; then inside that, 1 to 4 intermediate layers of polyhedral compacted cells; and inside this a thinner area of hyaline tissue that gives rise to narrowly ampulliform pycnophores. Grove (295, 296) lists Septoria graminum Desm. var. crassipes Grove on leaves of wheat and states that this variety has short ampulliform cuspidate sporophores measuring 10-13 x 2.5-3 µ. Grove's illustrations (295) indicate that he had the same fungus as the one on wheat in the western United States. The western material has flask-shape to almost cylindrical pycnophores measuring 5-13 x 1.3-3 µ (Sprague, (665, fig. 1).

Septoria tritici produces both microspores and macrospores. The macrospores are the more prevalent; they are 1- to 5-septate, narrowly obclavate-filiform, hyaline, 22-98 x 1.4-2.1 µ, mostly 45-80 x 1.6-2.0 µ. Summer material, often erroneously called S. graminum Desm., tends to more nearly filiform spores, shorter and with fewer septa.

Microspores are curved or hooked, aseptate, 5-9 x 0.3-1 µ, and are borne in small pycnidia 45-50 µ. The spores are so minute that they have no doubt been mistaken for bacteria. In pycnidia, 55-70 x 60-80 µ, sometimes both microspores and macrospores occur. Microspores may be produced on the tips of ampulliform pycnophores or on the tips of aborted macrospores (Sprague, 665, fig. 1). The microspore stage has been reported only from Oregon but has likely been overlooked elsewhere.

Septoria tritici occurs on Triticum aestivum, T. spelta, T. dicoccum var. farrum Bayle, and T. turgidum L. It is an important parasite on winter wheat in the moister parts of Oregon, Washington, and California and sometimes is serious in Nebraska and Kansas. It is less common east of the Cascade Mountains in Oregon and Washington and becomes decreasingly important eastward until it is virtually nonexistent in the Spring Wheat Belt of the Northern Great Plains. In parts of Oregon and Washington winter rosettes of wheat are 100 percent covered with the salt and pepper lesions of S. tritici and this injury cannot but have a depressing effect on the host, even though the fungus often disappears entirely when warm, drier weather comes in spring and summer.

It has been shown by Weber (753) that S. graminum does not occur on wheat in Wisconsin, while the writer reported that S. tritici was the only filiform-spored species present on wheat in the United States (665) and that S. graminum (642) was apparently limited to Brachypodium spp. and does not, as far as known, occur in this country. Most of the species that the writer assigned to synonomy are obvious synonyms, but

one, _S. briosiana_ Mor. (473), is less obvious. In this form microspores (9-11 x 0.5-0.75 µ) are borne on more or less abortive macrospores (32-40 x 1.5-2.0 µ). Similar conditions have been noted in this country.

Septoria tritici produces mucose, flesh color colonies, on potato-dextrose agar, which later become carbonaceous, finally subcottony.

Roberge, not Desmazières (153), should be credited with the naming of this species.

References: Baudyš and Picbauer (25); Beach (28); Cormier (130); Desmazières (153-155); Grove (295, 296); Luthra et al. (416, 417); Morini (473); Rivera (536); Rosella (542); Saccardo (555,556); Sprague (642, 665); Unamuno (731); Weber (753).

SEPTORIA TRITICI f. _AVENAE_ (Desm.) Sprague, Speckled Leaf Blotch.

At one time the writer (626) concluded that _S. tritici_ on oats was nothing more than a physiologic race of the species, but further study disclosed that the form on oats is distinguishable by its more sinuous spores averaging slightly narrower than those on wheat. Forma _avenae_ is limited to oats and does not attack wheat or any known grass. The form occurs on _Avena sativa_, _A. byzantina_ (red oats), and _A. fatua_ (wild oats) in Oregon and Washington, and in Europe, New Zealand, and Argentina. It is seldom abundant except during moist open weather in winter in the Willamette Valley and adjacent areas. Red oats and wild oats are particularly susceptible.

References: Desmazières (155); Sprague (626, 665).

SEPTORIA TRITICI f. _HOLCI_ Sprague, Speckled Leaf Blotch.

Cross inoculation trials show that this fungus is confined to _Holcus lanatus_. It is common in wet weather in the winter and early spring in western Oregon and Washington. The spots are irregular, eventually umber color, with numerous pycnidia. The spores are long, filiform, 1- to 4-septate, 35-105 x 1.3-2.0 µ, and are narrower and longer than typical _S. tritici_ on wheat.

Reference: Sprague (665).

SEPTORIA TRITICI var. _LOLICOLA_ Sprague and A. G. Johnson, Speckled Leaf Blotch.

The lesions are at first green or yellowish but later turn fuscous to deep brown. The pycnidia are obscure because of the dark color of the older lesions. They are subglobose to globose, sometimes ellipsoid,

80-150 x 90-180 μ, mostly 120-150 x 120-150 μ in diameter. The spores are hyaline, sometimes with coarse protoplasm, sometimes containing small oil drops, which in slightly immature specimens are as large as 1 u in diameter. The spores usually are slightly enlarged at the base, curved or sinuous, sometimes whip-like, 0- to 5-septate, commonly 1- to 3-septate, 21-85 x 1.3-2.8 μ (Sprague, 665, fig. 2). On Lolium perenne and less often on L. multiflorum, the spores are often more variable, with short, 1-septate spores occurring with the larger ones. They differ from those of S. tritici on wheat in the slightly more whip-like appearance due to the slightly enlarged bases and somewhat more tapering distal portions.

Septoria tritici var. lolicola occurs on L. perenne and L. multiflorum in western Oregon and in France. The early taxonomy of this fungus is greatly confused. Desmazières, no. 2169 in his Fungi Cryptogames de France (1851), described S. graminum var. lolii Mont., which now appears to be a smaller spored fungus, Ascochyta desmazieri Cav. (99). But var. lolicola was also present in this material, as well as Rhabdospora lolii Cast. (98). The latter fungus was transferred to Septoria under the name S. lolii by Saccardo (in Sylloge Fungorum v. 10), who failed to note S. lolii West. (763) which latter is the same as A. desmazieri. The fungus called R. lolii Castagne, according to rules of nomenclature, was nameless and hence was transferred to S. loligena by the writer. In all this welter of names, the filiform spored Septoria also escaped without a name and was therefore called S. tritici var. lolicola.

References: Castagne (98); Cavara (99); Desmazières (156); Sprague (665); Westendorp (763).

STAGONOSPORA SPP.

Key to species:

A. Spores over 8 μ wide (30-45 x 8-11 μ) .... Stagonospora simplicior Sacc. and Berl.

AA. Spores narrower

B. Spores somewhat boat-shape, 20-35 x 6-8 μ .... St. subseriata Desm.

BB. Spores more or less cylindrical

C. Spores somewhat fusiform, 15-30 x 2-3.2 μ

D. Spores somewhat truncated at base .... St. agrostidis f. angusta Sprague

DD. Spores more fusiform than truncated .... St. bromi A. L. Sm. and Ramsb.

CC. Spores definitely cylindrical

D. Spores 25-70 x 2.5-5 µ .... St. arenaria Sacc.

DD. Spores 30-80 x 4-9 µ .... St. foliicola (Bres.) Bub.

This genus Stagonospora is separable from Septoria with difficulty, because on grasses there is a group of fungi, some placed in Septoria, some in Stagonospora, that have spores about 30-40-60 µ long x 3-4-6 µ wide and therefore lie on the border between filiform and cylindrical. Some workers consider Stagonospora as having coarse spores similar in all respects to Hendersonia, except for color, and similar also to Hendersonia in being mainly weak parasites or saprophytes (Kirschstein, 384). There are exceptions to this classification that make its value questionable. In general, the writer uses the length-width ratio of 10 to 1 as the division point between cylindrical and filiform. Since the length of the spores of many of these species range from about 9 to 1 to 13 to 1, they become difficult to classify. In such cases they are left in the genus to which they are customarily referred; e.g. Septoria nodorum, Stagonospora arenaria, Septoria avenae, and Stagonospora arrhenatheri A. L. Sm. and Ramsb. The forms with filiform spores produce yeasty masses of conidia on germinating on potato-dextrose agar while those with cylindrical spores are more likely to produce cottony mycelium and produce spores in true pycnidia. However, some produce small crustose colonies in which pycnidia are embedded in a matrix (Septoria infuscans), so that at least three groups are recognizable. If we place these intermediate forms in Septoria, the genus should be segregated into three sections as follows:

A. Spores filiform or narrowly obclavate, producing conidia from germinating spores on potato-dextrose agar......Section Filisporae (Various typical species of Septoria)

AA. Spores clavulate or coarser, producing pycnidia in crustose colonies on potato-dextrose agar........ Section Clavulosporae (Species such as Septoria infuscans)

AAA. Spores narrowly cylindrical, producing spores in true pycnidia in pure culture on potato-dextrose agar.... Section Cylindrosporae (Species such as Septoria nodorum, S. avenae, S. loligena, S. secalis, S. melicae, S. oudemansii and S. agropyrina)

STAGONOSPORA AGROSTIDIS f. ANGUSTA Sprague, Leaf Blotch.

This is an obscure fungus associated with other fungi on leaves of

Stipa viridula in western North Dakota (Sprague, 666). It has fusiform spores but the bases are characteristically sub-obtuse or truncated. The spores are small, 15-27 x 2.2-3.2 µ, borne in globose, golden-brown pycnidia, 120-280 µ in diameter. It is probably of slight importance economically. Morphologically it is closest to St. agrostidis Syd. (697, p. 4). The spores differ in shape from those of Septoria nodorum.

STAGONOSPORA ARENARIA Sacc., Purple-brown Blotch.

In well-developed but not old-weathered material, the spots or blotches are purple-brown, purple or nearly sepia or deep brown. Older material may be light straw color with tawny borders or old material may be completely faded to neutral straw color. The lesions are sometimes numerous, as on Fluminea festucacea (Willd) Hitchc., or sometimes scattered and obscure, as on Elymus. The lesions do not retain their dark color very long but fade in the center, paling to the neutral straw color mentioned above. St. arenaria occurs on several species of Elymus and Agropyron and morphologically similar material occurs on Cinna latifolia (Trevir.) Griseb., Oryzopsis hymenoides, and Fluminea festucacea in the western area. On Elymus and Agropyron, this fungus merges with Septoria nodorum, S. avenae, and S. agropyrina, as mentioned previously, and there exists some uncertainty as to where to draw species lines in this polymorphic group. Since the publication of an earlier article (Sprague, 653), it has been determined that the fungus on Phalaris is an immature or small-spored phase of St. foliicola (Sprague, 666; and below under St. foliicola). It is now apparent, also, that St. arrhenatheri should not be classed with St. arenaria but with Septoria avenae, from which even St. arenaria is doubtfully distinct on some hosts.

Host range studies are needed with this group in order to determine racial affinities of St. arenaria. It is no doubt a complex of races.

References: Sprague (653, 665, 666).

STAGONOSPORA BROMI A. L. Sm. and Ramsb., Purple-Brown Blotch.

This fungus causes a purple-brown blotch on the leaves of brome grasses. The disease is very destructive in Michigan (Hardison, 310) and the writer has collected it on Bromus carinatus in grass plots at Park River, North Dakota. He also recently found it on B. vulgaris (Hook.) Shear near Lake Itasca, Minnesota.

The fungus has 3-septate fusiform spores, mostly 17-24 x 3 µ. Its life history should be studied in comparison with Septoria nodorum, but it appears to be different. St. bromi is much more parasitic than St. agrostidis f. angusta and the spores are clearly hyaline and with less truncate bases.

References: Grove (296); Hardison (310).

STAGONOSPORA FOLIICOLA (Bres.) Bub., Tawny Blotch.
(St. vexata var. foliicola Bres., St. vexata var. baldingerae Sacc.)

This is an active parasite on the leaves of Phalaris arundinacea in North Dakota, South Dakota, Iowa, Minnesota, and Wisconsin. It also occurs on P. californica Hook. and Arn. in Marin County, California. In field plots at Mandan, almost all of the leaves are covered with the tawny blotch in late season. Some difference in susceptibility was noted among plants in this nursery.

In the Mandan material, the spores are hyaline, multiseptate, and very large, 30-80 x 5-9 μ, obclavate-filiform to obclavate-cylindrical. (Sprague, 666). All of the material that has been seen previously was immature and resembled somewhat fusiform material of St. arenaria (Sprague, 653). From a study of developing material at Mandan during the summer months, it is now evident that these collections are clearly part of the life cycle of the coarse-spored St. foliicola. The inclusion of this material in St. intermixta (Cke.) Sacc. by J. J. Davis (144, p. 73), who had only the developing phase, had confused the writer in earlier studies. The fungus produces a white to pale pink, somewhat weak cottony growth on potato-dextrose agar.

STAGONOSPORA SIMPLICIOR Sacc. and Berl., Leaf Mold.

This species is, for the most part, a saprophytic leaf mold. The symptoms consist of vague stramineous or gray areas on dead leaves. Pycnidia are more or less gregarious, 100-140 μ in diameter in our material, black, globose, ostiolate; and the pycnospores are cylindrical or slightly bent, obtuse, slightly or scarcely constricted at the septa, 3-septate, with coarse contents, often one huge hyaline inclusion in each cell; spores are hyaline or faintly yellow, borne on blunt pycnophores, 28-35 x 8-9 μ on Calamovilfa longifolia in North Dakota as compared with 32-38 x 8-9 μ on Phragmites communis in the type from France. Our local material, collected in September on dead leaves, appears to be saprophytic. However, St. simplicior var. andropogonis Sacc. was described from North Dakota (Dr. J. F. Brenckle). Greene sent material of a fungus on Sorghastrum nutans from Madison, Wisconsin, that he determined as this variety, and it appears to be parasitic, causing elliptical spots on living leaves. St. simplicior is likely to prove rather widespread on coarse grasses in our region but, except for the Wisconsin material, it has not, as mentioned, been shown to be associated with living host parts.

STAGONOSPORA SUBSERIATA (Desm.) Sacc., Leaf Mold.

This species has boat-shaped spores 20-40 x 4-7 µ borne in pycnidia on various hosts in the western United States (Sprague, 652). It occurs on Poa pratensis and Phleum pratense in northern Minnesota. The species appears to be saprophytic on most of the hosts seen. St. subseriata var. maculata Grove (296) is an active parasite, however, on orchard grass in England (Grove, 296), Pennsylvania (Sprague, 652), and Maryland.

References: Grove (296); Sprague (652).

STAGONOSPORA SPP., Molds.

A considerable number of species of Stagonospora occur on dead culms, leaves, and sheaths of grasses. These are particularly common on coarse marsh grasses such as Phragmites communis. So many species have been described on this grass, for instance, that it is practically impossible for most workers, and that includes the writer, to determine these with available facilities. Since most or all of these fungi are saprophytes their interest is purely mycological and of no importance to the pathologist.

WOJNOWICIA GRAMINIS (McAlp.) Sacc. and D. Sacc., Secondary Rootrot.

This fungus was removed from Hendersonia because of short hairs on the neck of the pycnidium. As a diagnostic character this has doubtful merit.

W. graminis is an associate of Cercosporella herpotrichoides in the prairies of the Columbia Basin but also occurs beyond this region into the dry land wheat regions of the West. It occurs commonly in Kansas, Colorado, and westward. It is not abundant in North Dakota in the spring wheat region, but is sometimes isolated from the roots or occurs on necrotic leaves of quack grass, orchard grass, and certain other species. It has been noted on about 29 species of Gramineae in the West.

Wojnowicia graminis, while scarcely parasitic, is of some economic importance because it weakens the culms of ripening grain, causing them to lodge prematurely. This condition is common in the Palouse in areas not affected by Cercosporella herpotrichoides. The effect of weak parasites and saprophytes on lodging of ripened grain has not been given sufficient attention. Carroll (95), in Eire, discusses this problem to some extent.

The spores of W. graminis are yellow brown, slightly flattened on one side, curved spindleform, 24-38 x 3-5 µ, usually 7-septate. An isolate from the roots of Agropyron repens in North Dakota had spores measuring

43-51 x 4.5-6 u but otherwise typical.

References: Broadfoot (68); Carroll (95); Ludbrook (413); McKinney and Johnson (448); Sprague (630, 667).

2. MELANCONIALES

COLLETOTRICHUM GRAMINICOLUM (Ces.) G. W. Wils., Anthracnose.
(C. cereale Manns)

Colletotrichum graminicolum is said to attack the roots, stems, leaves, and spikes of cereals and grasses, causing spots and injury generally known as anthracnose in which the black spots due to pustules (acervuli) produce a somewhat scab-like effect on the diseased surface. The fungus may develop saprophytically in late season with little evidence of its presence except for setae which give the diseased part a slightly moldy appearance.

In our area it occurs on Agropyron desertorum (Fisch.) Schult. A. repens, A. trachycaulum, Agrostis alba, Alopecurus aequalis Sobol, A. pratensis L., Andropogon furcatus, Anthoxanthum odoratum, Arrhenatherum elatius, Avena fatua, A. hookeri Scribn., A. sativa, Bromus purgans L., Calamagrostis inexpansa, C. rubescens Buckl., Dactylis glomerata, Digitaria sanguinalis, Festuca octoflora Walt., Hordeum vulgare, Lolium multiflorum, L. perenne, Oryzopsis micrantha (Trin. and Rupr.) Thurb., Phleum pratense, Poa pratensis, Schizachne purpurascens (Torr.) Swallen, Secale cereale, Sorghum vulgare var. sudanense (Piper) Hitchc., Sphenopholis obtusata, Sporobolus heterolepis, Trisetum cernuum, and Triticum aestivum. The fungus is particularly common on Anthoxanthum and Arrhenatherum in the coast region of Oregon. While common in Minnesota, it is less prevalent in the drier regions to the west.

The acervuli have prominent black setae 60-120 x 6-8 µ. The conidia are spindle-form to falcate, 18-26 x 3-4 µ, borne on short conidiophores, 12-6 x 1-2 µ.

Bolley (1913) reported Colletotrichum on the roots of wheat in North Dakota. The illustration indicates that he was dealing with a fungus that the writer has isolated in large numbers from diseased roots of many cereals and grasses. The cultures produce pink or orange slimy yeasty (mucose) masses of kidney-shape or falcate spores 4-8 x 1.4-2.5 µ. The colonies later develop black leathery wrinkled mycelium in which Phoma-like bodies sometimes occur, or less often there may be strands of pseudo-setae which never develop into true horny setae. Inoculations with a number of these isolates have been negative, although in one case an isolate obtained in August was parasitic on several hosts. Subsequent trials with this were negative and the end result in doubt. The writer has called these cultures Gloeosporium

spp. Whether they are a phase of C. graminicolum is doubtful. Certainly they are different in culture from "C. cereale" of Selby and Manns (589). Selby and Manns obtained true mycelium development on glucose agar without mucose development of spore masses. Setae were sparingly produced and the spores were falcate, not dissimilar to those on the host. The North Dakota Gloeosporium resembles in its development some strains of Colletotrichum gloeosporioides Penz. in pure culture (Burger, 83) although the spores of the latter are larger.

References: Böning (60); Bolley (56); Burger (83); Chowdhury (105); Fischer, et al. (231); Koehler (386); Sanford (576); Selby and Manns (589); Wilson (766); Winter (773).

GLOEOSPORIUM GRAMINUM Rostr., Anthracnose.

What answers to the description of this fungus was found on leaves of Poa pratensis in two localities in Benton County, Oregon, (Sprague, 637). It may be related to the Gloeosporium-like fungus reported under Colletotrichum graminicolum above.

PSEUDODISCOSIA AVENAE Sprague and A. G. Johnson, Red Leather Leaf

In western Oregon and Washington, entire fields of winter oats sometimes show a brilliant red color in February and March. In other cases, the disease is confined to small scattered patches in which the leaves nearly all show a general reddish or reddish-brown color. All but the innermost leaves of a plant may be affected. These lesions cause a leathery, fawn to red or brown appearance. An excess of red anthocyanin pigmentation in the uninjured portions of diseased leaves gives the reddish-brown color of affected plants. The diseased plants are stunted, compact, and rigid; and the leaves are slightly rolled.

This fungus is widespread on common and red oats in the vicinity of Corvallis, Oregon, in the winter and early spring and may also be found as far east as southwestern Klickitat County, Washington. The type locality is an isolated high prairie in the latter region near the Columbia River gorge. In this area the diseased plants of Winter Turf (Gray Winter) oats showed 40 percent reduction in yield over the healthy ones. The disease is of some importance, although the oats recover to a considerable extent as soon as warm weather arrives in the spring. "Red leather leaf" is almost unrecognized as a definite disease, even at Corvallis, the symptoms being confused with red leaf symptoms in general (Sprague, 644). Many specimens of this disease are mailed to the Oregon Agricultural Experiment Station. It occurs only on fall-seeded oats.

Recently Bremer (64) reported this fungus from Turkey where it appears to be indigenous.

Pseudodiscosia avenae produces the fusiform, basally ciliated spores on very short conidiophores compacted together on a poorly developed stroma in the epidermis. There is no apparent rupture of the leaf epidermis as in typical acervuli, and in assigning this originally to the Melanconiales, the describers considered the stroma as closer to the Melanconiales than to the Moniliales (Sprague and A. G. Johnson, 672). There still appears to be no better place to assign this species.

References: Bremer (64); Sprague (625, 628, 632, 641, 644); Sprague and A. G. Johnson (672).

SEPTOGLOEUM SP.

This fungus causes dark brown to black lesions on the pedicels and foliage of Festuca idahoensis Elmer near Trude, Idaho. The spores are large, stoutly club-shape to cylindrical with blunt bases and tapering apices, which are sometimes pointed. They are usually aseptate, hyaline, 44-53 x 4.6-5.6 μ. This fungus is distinct from any species known to the writer. Until final study can be made with prepared material the fungus is assigned to Septogloeum rather than Septoria.

Reference: Sprague (669).

SEPTOGLOEUM OXYSPORUM Sacc., Bomm., and Rouss., Blotch and Char Spot.

The young lesions on the leaves are tawny with yellow margins, circular at first but soon elliptical to elongate. On Arrhenatherum elatius the fungus rarely forms black stromata, but on other hosts the lesions caused by a similar if not identical fungus become covered with dull-black, charcoal-like streaks, 2-5 mm wide and often several times as long. While the charcoal spots range from nearly circular to elongate they are typically elongate, tapering to a point at each end. The center of the lesion is often paler than the periphery, being pale gray or isabelline from accumulation of conidia in some instances. Sometimes pycnidia occur as small black dots at the margin of the lesion, but more often, if they are present, they are obscured by the charcoal-like stroma and are not visible to the naked eye.

Spores are borne in stromatic tissue in obscure acervuli or in pycnidia in the center of the lesions, conidia arising from hyaline, globular or cuspidate conidiophores in great, grayish masses; conidia yellow to subhyaline, fusoid, often flattened slightly on one side, subtruncate at the base, tapering to an obtusely pointed apex. The conidia are 0- to 3-septate, mostly 2-septate, 17-38 x 2.5-5.9 μ; on Agrostis, they are 21-31 x 3.2-4.4 μ; on Arrhenatherum, 24-33 x 3.5-4.7 μ; on Calamagrostis, 22-27 x 3.5-4 μ; on Distichlis, 20-25 x 4.3-5 μ with relatively short, thick spores ranging from fusoid to nearly cylindrical; and on Elymus and Agropyron, they are variable, 17-38 x 2.5-5.0 μ.

Pycnidia in the char spots are subglobose, brown, more or less imbedded in the creosote brown stromatic tissue, or separate at the margin of the lesions, 80-160 µ in diameter, with variable ostioles sometimes 60 µ in diameter. The pycnospores are similar to the conidia but are hyaline. Associated perithecia in the stroma are globose and up to 250 µ in diameter and are sometimes filled with hyaline prosenchyma. The perithecial walls are composed of creosote-brown compacted polygonal cells. The asci consist of short fascicles without paraphyses but in material seen to date on Elymus condensatus none of it is mature enough to determine.

Synonyms:

Mastigosporium album var. athrix Eriks. Fungi par. scan. exsicc. Fasc. VIII, 351-400. 1891. (Bot. Centralbl, 47: 296-298. 1891).
Fusoma biseptatum Sacc. Krieger, W. Fungi sax. exsicc. Fasc. XIV, no. 683. 1891
F. triseptatum Sacc. Sylloge Fungorum v. 10. 1892
Fusarium osiliense Bres. and Vest. Vestergren, Verzeichniss nebst Diagnosen und kritische Bemerkungen zu meinem Exsiccatenwerke "Micromycetes rariores selecti." Fasc. VII-X. Botan. Notis. 1900: 27-44. 1900
Septogloeum athrix (Eriks.) Sprague (640)

The host range of Septogloeum oxysporum includes the following hosts listed by States: Agropyron spicatum (Wyo.); A. trachycaulum (N. Dak., S. Dak.); Agrostis hallii (Oreg.), A. alba (Wyo.); A. scabra (N. Dak.); Arrhenatherum elatius (Oreg.); Bromus ciliatus (Colo.); Calamagrostis inexpansa (N. Dak.); Distichlis stricta (Torr.) Rydb. (N. Dak.); Elymus condensatus (Calif., Wyo., Mont., Wash.); E. glaucus (Utah); E. triticoides (Calif.); Muhlenbergia asperifolia (N. Dak.).

This fungus is not of great importance but at times is epiphytotic on grasses in humid areas.

There is still reason to question whether true S. oxysporum that occurs on Arrhenatherum is the same species as the char spot fungus found on other hosts. Life history studies are certainly needed. The char spot fungus with its Septogloeum-like stage is associated with an ascomycete which is close, taxonomically, to Dothidella aristidae. The entire charspot-tarspot situation is still further confused when the discussion by Greene (289, pp. 86-87) is noted, regarding Davisiella elymina (J. J. Davis) Petr. and other fungi. Members of the group Davisiella are either conidial phases of Phyllachora spp., or are associated saprophytes or even parasites. They appear to form part of the same over all problems as does the char spot and Septogloeum complex. The writer agrees with Greene that likely more than one fungus is involved in the whole Middle Western and Far Western situation.

References: Bommer and Rousseau (57); Greene (289); Sprague (651).

SEPTOGLOEUM SPARTINAE (Ell. and Ev.) Wr.
(Fusarium spartinae Ell. and Ev.)

This fungus has not been seen by the writer. The sporodochia are pale-yellow, floccose; conidia oblong elliptical to oblong fusoid, 1-3 septate, 12-15 x 3-4 µ. Saccardo (558, v. 18, p. 675) lists it on Spartina stricta (= S. leiantha Benth.) from Pacific Grove, California. It is listed by Seymour (599) on S. alternifolia Loisel. var. glabra (Muhl.) Fern. (= S. alternifolia Loisel).

References: Ellis and Everhart (216, p. 14); Saccardo (558, v. 18, p. 674-675); Seymour (599); Weiss (757, p. 547); Wollenweber and Reinking (776, p. 336).

3. MONILIALES

ALTERNARIA SPP. (and STEMPHYLIUM SPP.), Black Molds.

Species of Alternaria occur as saprophytes on aerial parts of many plants. They are one of the components of seed mold of wheat, called "black germ" in Siberia, "puntatura" in Italy, "moucheture" in Morocco, and such names as "kernel smudge", "black point" (in part), seed blight or "durum blight" in the United States and Canada. A melanistic (black skin pigment) browning of wheat lemmas is termed "Alternaria blotch" by Johnson and Hagborg (374).

Almost all careful research on Alternaria molds on wheat shows that they are saprophytic or at most, scarcely parasitic. They are economically important in that their presence may cause dockage losses to the grower, particularly in North Dakota durum wheat used for macaroni (Brentzel, 65).

The taxonomy of this group is in some confusion. Generally A. tenuis Nees is recognized as the common mold on Gramineae while Bockmann (54), among others, includes A. peglionii Curzi and A. circinans (Berk. and Curt.) Bolle.[4]

A. tenuis is isolated frequently from dead roots of old grass and cereal plants and less often from roots of seedlings. Our trials do not show any reason to believe that the fungus is parasitic to any extent on germinating seeds (Sprague, 663). This was shown by E. C. Johnson (372) 32 years ago.

Because A. tenuis is often associated with more parasitic species, such as Helminthosporium sativum Pam., King, and Bakke, moldy wheat seed should be treated with New Improved Ceresan at 1/2 oz. per bushel,

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[4] The writer is indebted to David R. Sumstine, Carnegie Museum, Pittsburgh, 13, Pa., for determination of the cultures of Alternaria isolated from Gramineae.

and grass seed with New Improved Ceresan at 1 oz. or Semesan at 4 oz. per bushel.

References: Bockmann (54); Bolley (56); Brentzel (65); Christensen and Stakman (113); Curzi (134); Elliott (206); Groves and Skolko (298, 299); Hagborg (303); Hanson and Christensen (309); Henry (321); Johnson, E. C. (372); Johnson, T. and Hagborg (374); Machacek and Greaney (420); Peyronel (514); Rosella (543); Sallans (562, 563); Wiltshire (768); Ziling (780).

ANSATOSPORA BROMI (Sprague) Sprague, Blotch
(Cercospora bromi Sprague)

Gray to sordid, elliptical or striate spots with broader dark brown or umber margins occur on Bromus rigidus Roth in two widely separated areas in Oregon and in southwestern Washington, and also on B. vulgaris in coastal Oregon.

This fungus is notable for the peculiar secondary conidia, which are attached and down-deflected from the first or second basal cell of the conidia. Evidence from study of material on B. vulgaris indicates that this species (A. bromi) may not be the cause of the spot on that host. On the basis of Newhall's study (481) of a disease of celery our fungus was placed in Newhall's newly created genus Ansatospora (Sprague, 666).

References: Newhall (481); Sprague (634, 655, 666).

CEPHALOSPORIUM ACREMONIUM Cda., Black-Bundle Disease.

This fungus occurs in the eastern part of the Great Plains and in California. It is thought to be the cause of a black fibrovascular bundle condition, which is accompanied by development of nubbins in corn, multiple ears at one node, barrenness and purple discoloration of the plant. The fungus is seed and seedling-borne. It was well described by Reddy and Holbert (530).

References: Corda (128); Harris (311); Koehler (385); Koehler and Holbert (388); Reddy and Holbert (530).

CERCOSPORA SPP.

This genus has been the subject of part-time investigations by Dr. Charles Chupp for many years. The reader is referred to his mimeographed article (114). One of our species, C. bromi, would on the basis of Chupp's suggestions to Newhall (481) belong in the genus Ansatospora Newhall to which we have referred it (Sprague, 666) (see above). The few species of Cercospora that occur on western grasses are briefly

mentioned.

References: Chupp (114); Newhall (481); Sprague (666).

CERCOSPORA AGROSTIDIS Atk., Leaf Spot.

This fungus forms broadly elliptical, very light brown lesions 3-5 mm long with broad dull red borders on leaves of *Agrostis* in Alabama. Some fragmentary material on *Sphenopholis obtusata* from North Dakota, sent by the writer to Dr. Chupp, was assigned to *C. agrostidis*. The conidia are hyaline to tinted, 1- to 7-septate, terete, straight or slightly curved, 10-60 x 2.5 µ.

References: Atkinson (20); Underwood and Earle (732, p. 141).

CERCOSPORA FUSIMACULANS Atk., Brown Blotch.

The lesions are amphigenous, light brown, bordered by dark brown, broadly fusoid or elliptical, frequently confluent, 3-4 mm long.

The conidiophores are epiphyllous, fasciculate, olive-reddish-brown, straight, sub-geniculate or nodulose, sparingly denticulate towards the apex, septate, 50-100 x 4-4.5 µ, bearing small, hyaline, 3- to 4-septate conidia that taper a little toward each end, 25-40 x 2 µ.

The rather obscure blotch symptoms have prevented this fungus from being recognized widely. It occurs on *Panicum pacificum* Hitchc. and Chase on the exposed slope of Mary's Peak, Oregon, (O.S.C. 9898), and occurs in the Great Plains on *P. virgatum* (N. Dak.), in Iowa on *P. dichotomiflorum*, and in Alabama on *P. dichotomum* L.

It is reported also on barnyard grass (*Echinochloa crus-galli*) from Iowa (Gilman and Archer, 262). In this connection, the writer recently sent to Dr. Chupp material of a spot on barnyard grass found along the Missouri River bottoms, near Mandan, North Dakota, (September, 1944). Dr. Chupp replied as follows: "I examined the *Cercospora* on *Echinochloa crusgalli* (L.) Beauv. which did not resemble the Davis type (of *C. echinochloae*) at all. For instance, *C. echinochloae* has more or less cylindric conidia, straight to strongly curved, 1-7 but mostly 2-3 septate, 3-5 x 20-55 µ. The conidiophores are hypophyllous, short, 4-5.5 x 10-25 µ. Your specimen has acicular to obclavate conidia, almost straight, multiseptate, 2-4 x 30-120 µ, and the conidiophores are amphigenous, 4-5 x 25-85 µ. In fact, according to my key, it meets the characters of *C. sorghi* E. and E. (Jour. Mycol. 3:15. 1887)." Dr. Chupp suggested that it would be important to determine if the fungus involved would attack sorghum.

References: Gilman and Archer (262); Underwood and Earle (732).

CERCOSPORA SEMINALIS Ell. and Ev., False Smut.

It is questionable whether this should be listed in a discussion of leaf spots because this particular fungus attacks the flowers of buffalo grass (Buchloë dactyloides (Nutt.) Engelm.), resulting in sterile seed balls containing the brown powder (conidia) of the fungus. The conidia are acrogenous, sub-hyaline, obclavate, granulose, 3- to 5-septate, 80-110 x 6-7 µ.

False smut is credited with being an important factor in reducing the yield of viable seed. Since re-grassing programs in some areas depend heavily on buffalo grass, false smut is important. Buffalo grass seed is usually pre-soaked before planting. Whether viable conidia of the fungus have any detrimental effect on the seedlings is not known, but no isolations have been made that indicate such is the case.

References: Ellis and Everhart (210).

CERCOSPORA SETARIAE Atk., Brown Leaf Spot.

This fungus produces a dark brown elliptical leaf spot with an indefinite pale border. It is reported on Setaria lutescens (Weigel) F. T. Hubb from Iowa. Tehon and Daniels (701) use the following key to distinguish three species of Cercospora on Setaria:

Conidiophores long, 50-120 µ

Spores 20-150 x 4-5 µ ..... C. setariae Atk.

Spores 45 x 1.5 µ ..... C. striaeformis Wint.

Conidiophores short, 17-40 µ ..... C. setariicola Tehon and Daniels

References: Atkinson (20); Tehon and Daniels (701).

CERCOSPORA SETARIICOLA Tehon and Daniels, Brown-Bordered Leaf Spot.

The old spots are elongate-elliptic with a cinereous center and a sharply delimited brown border. The spores are 4- to 12-septate, 30-90 x 3-4 µ. The writer has collected this fungus on Setaria lutescens at McCanna, North Dakota.

References: Tehon and Daniels (701).

CERCOSPORA SORGHI Ell. and Ev., Leaf Spot.

This is reported as a leaf spot on Johnson grass (*Sorghum halepense* (L.) Pers.) from Nebraska. It is common on sorghums farther south. The spores are said to be hyaline, 70-80 x 3 µ (Ellis and Everhart, 209). (See also discussion under *C. fusimaculans* above).

CERCOSPORELLA Spp.

Until recent years, there were no species of *Cercosporella* recognized on grasses. There are at present four known for the region. They may be distinguished by the following key:

A. Attacks base of culm causing foot rot, spores 30-80 x 1.5-3.5 .. *Cercosporella herpotrichoides* Fron

AA. Attacks leaves causing leaf spot or scald

B. Causes an eyespot lesion on leaves of *Poa pratensis*, spores 45-90 x 3.6-5 µ .... *C. poagena* Sprague

BB. Causes a scald or non-eyespot type of leaf spot

C. Conidia subulate, 20-35 x 2.5-4.3 µ .... *C. subulata* Sprague

CC. Conidia filiform, 40-105 x 1.5-3 µ.....*C. holci* Sprague

CERCOSPORELLA HERPOTRICHOIDES Fron, Cercosporella Footrot.

In the United States, the *Cercosporella* footrot is restricted to some high prairies in the winter wheat area in the Columbia Basin, where the precipitation is 14 to 25 inches and the climate not severe.

Fawn-color to white elliptical lesions with brown borders form at the ground line on the stems in early spring. Stromatic mycelium eventually covers the base of the culms with black, charred-appearing hyphae. The culms break over at this point. Seriously diseased fields have characteristically pale green leaves and smaller heads than normal. Later, so much of the grain may be broken over and tangled together that harvesting is very difficult.

Winter wheat and wheat relatives (*Triticum* spp.) and also barley (*Hordeum* spp.) are susceptible, while rye is more resistant and oats highly so. *Aegilops* spp. (Sprague, 655, 656), crested wheatgrass, *Agropyron inerme*, *A. riparium* Scribn. and Sm., *Bromus carinatus*, *B. inermis*, *B. tectorum*, *Koeleria cristata*, *Poa secunda* Presl, and

Sitanion hystrix have all been found carrying the fungus.

Cercosporella herpotrichoides is greatly favored by open warm wet winters, which induce excessive growth in winter wheat or barley.

Olympia barley, Rex, Hymar, or Holland wheat (High Prairie, Washington) are preferred over bearded Turkey types of wheat in areas where this footrot occurs. Short straw is preferred to tall. Seeding should be delayed in the fall for a few days past the optimum date to reduce the chances of excess vegetative growth. Calcium cyanamid, 100 lbs. per acre increased yield.

References: Adam (4); Foëx and Rosella (233, 234); Fron (240); Glynne (264-267); Gorter (280); Heald (314); Moritz and Bockmann (476); Oort (494); Saxby (584); Sprague (620, 622, 624, 631, 635, 643); Sprague and Fellows (671).

CERCOSPORELLA HOLCI Sprague, Buff Scald or Tan Leaf Spot.

This fungus is very common in western Oregon and Washington on Holcus lanatus. The spots are tan, yellow-bordered to darker buff or tawny, elliptical or extensive scald-like lesions on any or all leaves of a plant. They develop in mid- to late- winter or early spring. In severe cases the injury resembles frost scalding or snow injury.

Conidia (1- to 9-septate, 40-103 x 1.5-3 μ) are produced in great numbers in winter, but in spring the conidia may be entirely absent. Such late spring lesions have been called nonparasitic by early workers who had not collected the fungus in the cold wet winter weather. This fungus is probably one of the reasons why velvet grass is not a satisfactory crop for pastures in western Oregon.

Reference: Sprague (634, fig.1).

CERCOSPORELLA POAGENA Sprague, Cercosporella Eyespot of Kentucky Bluegrass

An eyespot lesion caused by this fungus has appeared in two places in western Oregon on Kentucky bluegrass. The lesions are circular to sometimes elongate, brown with yellowish border, often straw color in the center and hence forming an eyespot type of injury.

The spores are hyaline, elongate, broadly filiform to obclavate with bases blunt, tapering, with the apices either abruptly acuminate or attenuate at the tips, 4- to 7-septate, 45-90 x 3.6-5 μ. It is known only from Forest Grove and East Corvallis, Oregon, and occurs in mid-early spring.

Reference: Sprague (657).

CERCOSPORELLA SUBULATA Sprague, Leaf Blast.

This fungus was originally described from a few gray to olive buff scald-like lesions on a herbarium sheet of a specimen of Melica subulata (Griseb.) Scribn. collected in the Ochoco National Forest in eastern Oregon. Since then it has been found on Deschampsia caespitosa (L.) Beauv. in the Montana mountains, in three places in western Oregon on Festuca rubra and on Melica bulbosa in the Big Horn Mts., Wyoming.

In pure culture on potato-dextrose agar an isolate from F. rubra produced a slow-growing fawn-color cottony growth that formed a few scattered conidia for a short time before staling.

The fungus is somewhat of a mystery as it appears to be both scarce and widespread, that is, it is never found in any abundance but has been found over a wide area.

The conidia have a characteristic, subulate shape with a whip-like distal portion. The conidia are 20-35 x 2.5-4.3 µ, mostly 28-33 x 2.8-3.5 µ. This fungus is now considered distinct from Cercosporella (Sprague, 668, in ms.).

References: Sprague (634, fig. 2, A, 668).

CLADOSPORIUM HERBARUM Lk., Mold.

See Mycosphaerella tulasnei (Jancz.) Rothers, its ascigerous stage.

CURVULARIA SPP., Mold.

These fungi sometimes cause molds, seed rots, leaf spots, seedling blights, and black kernels. In general they are saprophytic molds on dead plant parts.

Curvularia Boed. (55) has 3- to 4-celled, brown, fusiform spores, typically curved or bent, with one or two of the central cells somewhat enlarged. The species are universal molds on countless kinds of plants and on debris in the soil. Because their classification is still in a state of flux they are considered here as a unit. Groves and Skolko (300) have presented the latest information on the group and the reader is referred to their paper. On the basis of the ratio of length to width of spore, almost all of our material from the Northern Great Plains falls in the species Curvularia geniculata (Tracy and Earle) Boed., to which we have been referring specimens for several years. The spores of this species are brown, 3- to usually 4-septate, and 24-46 x 8-14 µ in pure culture. Our material resembles an Australian species, which Hynes (348) has reported as C. ramosa (Bainier) Boed. The spores from one of Hynes' collections average 32.6 x 13 µ, and those from

another, 35.3 x 13.3 µ. According to the method used by Groves and Skolko, both of these would belong to the "geniculata" group and close to C. geniculata, but they place C. ramosa as a synonym under C. inaequalis (Shear) Boed. C. inaequalis has proportionately somewhat stubbier spores than C. geniculata. Groves and Skolko report C. inaequalis on seeds of grasses and certain other crops in Canada. As they state, the problem is by no means solved and needs further study. We prefer, for the present, to leave all of the "geniculata" material in C. geniculata although admitting that there are distinct differences in isolates.

Besides the great number of isolates of Curvularia geniculata obtained from the roots and seeds of many cereals and grasses in our area, we have isolated another species, confined largely to Echinochloa crus-galli. The spores are olive-green rather than brown, and are very short and thick, sometimes almost triangular in outline. These have been referred to C. trifolii (Kauff.) Boed., but need to be compared with several species of Helminthosporium for a possible earlier name. C. trifolii belongs in the 3-septate "lunata" group. C. lunata (Wakk.) Boed. itself is an exceedingly abundant mold in the tropics and probably occurs on rice and some weeds within the bounds of this report. It is a nuisance on rice grains in the southern United States.

Wernham and Kirby (762) reported Curvularia sp. as associated with a "going-out" or "melting-out" disease of Poa annua and Agrostis palustris (Metropolitan bent) during hot weather. This fungus grew best at 30° C and was inhibited if the temperature dropped below 25° C.

Bunting (81) did not find that C. lunata was conclusively parasitic on corn in the Gold Coast of Africa.

Hynes (345) found that there were 11 races of C. ramosa (Helminthosporium-M) associated with wheat in Australia. Hynes believed that this species or races of it were more virulent than either H. sativum or H. tetramera McK. (C. spicifera ?). Hynes' forms of C. ramosa differed considerably, one from another, in pure culture.

In the Northern Great Plains the writer (663) has found that most isolates of C. geniculata were nonparasitic on seedlings of many grasses and cereals; in a few cases, however, isolates were parasitic on certain grasses, but scarcely so on cereals. One culture, 367 B-6, isolated from seedlings of Agropyron sibiricum in mid-April, caused injury to roots of crested wheatgrass (A. cristatum), and moderate injury to sudan grass. Most isolates caused some injury, mostly pre-emergence killing, to proso millet and blue grama when added to the soil at seeding time. In general, however, C. geniculata appears to be a saprophyte on the roots, culms, leaves, and inflorescences of Gramineae and other plants in the northern United States.

In culture Curvularia geniculata produces a luxuriant dark gray to

nearly black, more or less stringy growth on potato dextrose agar. Other isolates are velvety black, similar to some isolates of H. sativum, and such isolates produce quantities of spores.

Cralley and Tullis (131), Matsuura (441), as well as Boedijn (55), report that C. lunata could cause a seedling blight of rice. Martyn (437) reported C. lunata on brown discolored palea of flowering heads of rice from British Guiana. He was able to cause the condition by inoculating with spores of C. lunata and incubating under humid conditions.

Nigam (482) isolated C. lunata from red spots on sorghum leaves and found that the fungus produced, on 2 percent rice agar, alternate zones of pink and white mycelium, pink in daylight and white in darkness. In continuous darkness the colonies were a dense, bottle-green color.

Sanitary measures to inhibit these molds, particularly in warmer climates, would appear to be difficult. However, such places as rice straw stacks (Martin 435) may be sources of abnormally heavy infection and can be eliminated. Martin and Altstatt (436) also recommend burning all weeds and volunteer rice around fields, keeping late seedings away from early ones so that spores are not spread during threshing of early crops, and keeping the grain and shocks dry to avoid heating.

When C. geniculata is very common on moldy grass seed, it might be desirable to treat with New Improved Ceresan 1/2 to 1 oz. per bushel depending on the size of the seed (a bushel of small seeds involves a great deal more surface than a bushel of wheat). Most of the writer's trials have not shown great benefit from treatment of range grass seeds except those infected with Helminthosporium sativum.

References: Bainer (21); Boedijn (55); Bunting (81,82); Cralley and Tullis (131); Groves and Skolko (300); Henry (321); Hynes (345, 348); Lefebvre and Johnson (400); Martin (435); Martin and Altstatt (436); Martyn (437); Mason (439); Matsuura (441); Nigam (482); Sprague (663); Tullis (718, 719); Wernham and Kirby (762).

FUSARIUM SPP.

The number of species of Fusarium that occur on Gramineae is not great, but the artificial system of classification in general vogue has multiplied the number of their subdivisions so as to represent a considerable array of fungi. Since some of these fungi, notably F. oxysporum Schlecht., are only weak parasites, it is more practical for the cereal and grass pathologist to recognize the species, and, in many instances, to ignore most of the subdivisions. Thus, in the case of such a complex as F. oxysporum, we prefer to use the all-inclusive F. oxysporum Schlecht. em. Snyder and Hansen, and, for all practical purposes, not explore the multiplicity of forms that are involved, inasmuch as this and certain other species are of comparatively little

consequence as parasites of cereals.

The student of Fusarium will naturally refer to Wollenweber's Fusarium autographice delineata (775), Wollenweber and Reinking's text (776), or the work of Raillo (518, 519). In North America, Snyder and Hansen (616) and Gordon (276, 277) have been followed. Gordon and the writer (278) have listed the common species of Fusarium isolated from Gramineae in the Northern Great Plains and this will serve as a guide to most of the species found in the plains country and westward. A key to these forms follows:

Key to Species of Fusarium on Western Grasses
(as grown on potato-dextrose agar in diffuse light at 70° F)

A. Typically producing red, pink, or wine color mycelium (sometimes color is scanty or absent in group with pip-shape (Sporotrichum) microspores)

B. Producing at least a few Sporotrichum-type microspores

C. Macrospores 1- to 3-septate .... F. poae (Pk.) Wr.

CC. Macrospores 1- to 5-septate .... F. sporotrichioides Sherb.

BB. No Sporotrichum-type microspores produced

C. Colony typically rosy pink; spore masses bright carrot color, often absent; macrospores somewhat acuminate at distal end, 5-septate average 45 x 4.1 μ, 7-septate 55 x 4.5 μ. (The common pink Fusarium on the roots of plants in the semi-arid Plains country) .... F. scirpi var. acuminatum (Ell. and Ev.) Wr.

CC. Colony white and rose or pink; spore masses carrot color; spores very narrow, 3-septate average 34 x 3.1 μ, 5-septate average 50 x 3.7 μ. (Common on the heads of Gramineae in moister regions) .... F. avenaceum (Fr.) Sacc.

CCC. Colonies bright carmine; spore masses orange red, often profuse; spores stout, not acuminate, 3-septate average 29 x 6.1 μ, 5-septate 38 x 6.6 μ, and 7-septate 46 x 7 μ. (Usually strongly parasitic) .... F. culmorum (W. G. Sm.) Sacc.

CCCC. Colonies carmine or darker; conidial masses bright orange; spores longer than in F. culmorum, proportionately narrower, 3-septate average 41 x 4.3 μ, 5-septate average 51 x 4.9 μ; 7-septate 73 x 5.4 μ. (Strongly parasitic) .... F. graminearum Schw.

CCCCC. Colonies white and bright rose; spores small, scarcely heeled, 1- to 3-septate, 1-septate average 16 x 2.8 µ, 3-septate 25 x 3 µ .... _F. nivale_ (Fr.) Ces.

AA. Typically producing a peach-color, later buff to nearly brown mycelium; macrospores typically acuminate on distal end

B. Macroconidia 3- to 5-septate. (Common on grass roots) ..... _F. equiseti_ (Cda.) Sacc.

BB. Macroconidia 3- to 7-septate, slightly more acuminate at apex than _F. equiseti_. (Appears to be much less common than _F. equiseti_, and very similar)........................ _F. scirpi_ Lamb. and Fautr.

AAA. Typically producing white or bluish mycelia

B. Microspores produced in chains; growth generally white on potato-dextrose agar .... _F. moniliforme_ Sheldon (The spores of var. _subglutinans_ are produced in heads or false heads which are clusters of spores adhering temporarily)

BB. Microspores not produced in chains

C. Colonies white, soon showing lavender, blue, purplish, or less often pink or even isabelline in the depth of the medium; mostly aseptate microspores, 7-10 x 2.1-3 µ; terminal and intercalary chlamydospores numerous. (Very common in roots of grasses in the Plains country) .... _F. oxysporum_ Schlecht. em. Snyder and Hansen

CC. Colonies becoming intensely blue in the depth of the medium; spore masses dirty cream to brownish; macrospores long cylindrical, fusiform, 3-septate 28-42 x 4.1-6.2 µ, 5-septate mostly 42-51 x 5-6.3 µ. (Saprophytic) .... _F. solani_ (Mart.) Appel and Wr.

This key is useful only in a general classification of the rootrot, mold, and scab fungi on Gramineae but has some value in aiding workers who still class all _Fusarium_ fungi as "spp."

References: Bennett (39); Carrera (93,94); De Haan (146); Gordon (276, 277); Gordon and Sprague (278); Padwick (500); Raillo (518, 519); Simmonds (609); Snyder and Hansen (616); Wollenweber and Reinking (776).

FUSARIUM AVENACEUM (Fr.) Sacc., Mold and Stem Rot.

This species apparently prefers marine or moist climates. It sometimes occurs as a parasite on rust spores on grasses in the western United States during rainy periods. The writer has seen it on a stem canker of orchard grass in the Cascade Mountains, Oregon. It has not been found on any rootrot material from North Dakota, although it occurs not far north of there in Canada (Gordon, 275). Johnston and Greaney (375) present evidence to indicate that it is a weak parasite. The fungus is readily recognized by its narrow macrospores.

References: Bennett (32); Gordon (275); Gorlenko (279); Johnston and Greaney (375); Wollenweber and Reinking (776, fig. 2, p. 52).

FUSARIUM CULMORUM (W. G. Sm.) Sacc., Rootrot and Head Mold or Scab.

Fusarium culmorum causes preemergence killing, stunting, and brown rootrot of cereals and grasses. The bases of some plants such as oats are sometimes covered with pink spore masses. It sometimes causes pink head mold or scab, and may even cause a small red-bordered sheath and leaf spot on wheat in the early season, as noted in the Palouse area of Washington. While the fungus is scarce in the Northern Great Plains, it is very common from central Montana westward. In the coast region, it and crown rust (Puccinia coronata Cda.) make the growing of oats somewhat hazardous. It is important east of the Great Plains also. In the Pacific Northwest it is an associate of Cercosporella herpotrichoides and of Helminthosporium sativum (dry land rootrot). Ledingham (399) found that F. culmorum was not inhibited by H. sativum but that the latter was inhibited by F. culmorum. There is increasing evidence that the various components of "common rootrot" are not entirely compatible.

Fusarium culmorum rootrot is one of the causes of red leaf in oats in Oregon and Washington (Sprague, 644). This symptom is particularly apparent in the Willamette Valley and in the vicinity of Moro, Oregon. Inoculation trials show that isolates of this fungus from North Dakota and Oregon are destructive parasites, far more parasitic than F. scirpi var. acuminatum.

The name Fusarium culmorum has been a catch-all for any pink or carmine tinted fungus in the United States. Very often F. scirpi var. acuminatum has been called F. culmorum, and the name has been used even for the entirely distinct F. equiseti and F. oxysporum. This accounts for the tendency to consider F. culmorum as a quasi-parasite of slight importance in some areas. Quite to the contrary, it is essentially as parasitic as F. graminearum; and where it occurs in quantity, it is to be reckoned with as a major problem, as it is in Canada and in the Pacific Northwest.

References: Bennett (32); Blair (50); Broadfoot (68, 69); Foster and Henry (236); Greaney (283); Ledingham (399); Rose (541); Sadasivan (561); Samuel and Greaney (575); Shen (603); Simmonds (607, 608); Sprague (663); Sprague and Fellows (671); Tyner (722, 723); Vosbein (748); Walker (750).

FUSARIUM EQUISETI (Cda.) Sacc. and F. SCIRPI Lamb. and Fautr., Secondary Rootrots.

These two similar species belong in the Gibbosum group which have the distal end of the macrospores pinched or narrowed. F. equiseti represents about 50 percent of all Fusarium spp. isolated from roots of Gramineae in April to June in the Northern Great Plains and is exceeded in numbers during the summer only by F. oxysporum. It first produces a peach color or apricot-tinted, cottony colony that later turns buff or medium brown. Microspores and later macrospores are produced in considerable numbers when grown in north light on potato dextrose agar. Putty color masses of macrospores, often without pseudopionnotes, are formed later. Neither of these species appears to be parasitic on cereal seedlings in trials at Mandan, North Dakota. (Sprague, 663). Bennett (34), however, found English strains of Fusarium scirpi var. pallens F. T. Bennett that were mildly parasitic on wheat and barley, while Johnston and Greaney (375) found that F. equiseti was moderately parasitic on older cereal plants. The isolates from the Northern Great Plains usually do not even cause destructive seed rots although at times they may reduce stands of blue grama to some extent, as do many weak parasites and molds (Sprague, 663).

References: Bennett (34, 37); Gordon and Sprague (276); Johnston and Greaney (375); Sprague (658, 663).

FUSARIUM GRAMINEARUM Schw., Seedling Blight, Scab.
(Ascigerous stage, Gibberella zeae (Schw.) Petch)

This well known cause of scab in cereals has been the subject of intensive study in the Middle West. An outline of recent studies up to 1940 is given by Dickson (160).

Fusarium graminearum is especially prevalent in southern Minnesota (Hanson, 305, 307) and is important westward into eastern South Dakota and the Red River Valley in extreme eastern North Dakota on spring wheat and barley. It is isolated occasionally from the roots of grasses in North Dakota west of the region where it occurs on cereals. It has been obtained from roots of Agropyron subsecundum, A. cristatum, and Agrostis sp. (P. I. 131,533) in western North Dakota, and from leaves of Poa pratensis near Jackson Hole, Wyoming, collected during very rainy weather in August 1941. It was isolated from barnyard grass and Hordeum nodosum growing in a moist ditch at Newell, South Dakota. It has not been reported authentically from the Far West. All cases attributed to

it in western Oregon have proved to be F. culmorum. Conners (122) indicates that it is rare in Manitoba.

References: Bennett (33); Conners (122); Dickson (159-161); Dickson et al., (162); Eide (200); Goddard (269); Hanson (305, 307); Henry (322); Ho and Melhus (330); Immer and Christensen (352); MacInnes (422); McIndoe (444); Melhus (459); Pearson (507); Senn (598); Sprague (663); Tu (714, 715).

FUSARIUM MONILIFORME Sheldon, Corn Ear Mold, Seed Rot.
(Ascigerous stage, Gibberella fujikuroi (Saw.) Wr.)

While this is a common mold on corn ears in the South and Middle West, it is somewhat less abundant in the Northern Great Plains, although Edwards (195) found it to be common on corn seed from Nebraska, and Hoppe (339) reported it as abundant even into Colorado. Boyle (62) reported that Ray isolated it from corn stalks from Pasco, Washington. It has been isolated by the writer from the roots of corn, sorghums, millets, and a number of grasses during the summer time in North Dakota. Our inoculation results indicate that it is a weak seedling parasite on small seeded grasses.

Recently Edwards (197), working with F. moniliforme and F. moniliforme var. subglutinans Wr. and Reinking, found that because the corn seed contained sufficient nutrient for independent seedling growth for 10 to 12 days, soil fertility did not influence the action of the parasite on the plant during this critical period.

References: Boyle (62); Dickson (160); Edwards 195-198); Ho (327); Hoppe (339); Koehler (385); Koehler and Dungan (387); Koehler and Holbert (388); Leonian (402); Sprague (663); Ullstrup (726, 728).

FUSARIUM NIVALE (Fr.) Ces., Snow Mold.
(Ascigerous stage, Calonectria graminicola (Berk. and Br.) Wr.)

In the United States, the status of snow mold due to Fusarium spp. has been in considerable confusion. It is said to be a common cause of turf injury in the Far West and from Minnesota eastward. Just how much actually is due to F. nivale is not known for certain. Fusarium snow mold is very common in Oregon during open rainy winter weather. Small, more or less circular areas, with a fringe of white or pinkish mass of mycelium and spores, are sometimes very conspicuous in bent grass lawns (Agrostis tenuis, A. palustris). Rhizoctonia solani and Fusarium culmorum, among other fungi, are prominent, but a species of Fusarium with a preponderance of 1-septate heel-less spores is most common, and this, at least, is referable to F. nivale but culture work and critical study are certainly needed.

A similar fungus with small falcate spores occurs on overwintering, lax leaves of Bromus tectorum, B. carinatus, B. rigidus Roth, Hordeum murinum L., and H. nodosum in the Columbia Gorge region of Oregon and Washington.

It is not unlikely that Fusarium nivale has been confused with F. oxysporum, although the species seem to develop at somewhat different seasons of the year in Oregon and Washington. In the eastern United States, recent work has shown that part of the snow mold is caused by Typhula itoana.

What is called Fusarium nivale occurs on Agrostis alba, A. palustris, A. tenuis, B. commutatus, Festuca rubra, F. rubra var. commutata, Poa annua and P. pratensis in Oregon; on A. palustris in Washington; and on Hordeum vulgare, Secale cereale, Agrostis alba, A. canina, A. tenuis, A. palustris and Festuca rubra in Minnesota. F. nivale var. majus Wr. (Wollenweber and Reinking, 776, p. 43, fig. 2, a) has been observed on winter leaves of Agrostis palustris in Lincoln County, Oregon.

References: Andren (12, 13); Bennett (35); Dahl (136); Dennis (151); Markvich (434); Monteith and Dahl (472); Nilsson (483); Sprague (655, 656); Wernham (761); Wollenweber and Reinking (776).

FUSARIUM OXYSPORUM (Schlecht.) emended Snyder and Hansen, Secondary Rootrot and Seed Rot.

While this fungus is very common on the roots of Gramineae, particularly during the summer, it does not appear to be very parasitic. The writer obtained moderate seed rot in some small-seeded grasses such as blue grama and in proso millet but on cereals the fungus was scarcely parasitic (Sprague, 663). Johnston and Greaney (375) obtained the same results on cereals. Simmonds and Ledingham (610) report F. oxysporum as nonparasitic on wheat and barley and slightly parasitic on oats.

The pink coloration in dead roots of oats and to some extent barley and wheat is largely due to a saprophytic development of F. oxysporum (Sprague, 663).

References: Gordon (276); Gordon and Sprague (278); Johnston and Greaney (375); Simmonds and Ledingham (610); Snyder and Hansen (616).

FUSARIUM POAE (Pk.) Wr., Silver Top, Secondary Rootrot, False Scab.

Poa pratensis is affected with a disease called silver top. The heads turn white and die prematurely. They are covered with a pale buff mold growth of Fusarium poae, associated with a species of mite (Pediculopsis graminum (Reuter) in some cases. Heald (313) showed a similar association of Fusarium and mite in bud rot of carnation, while Stewart and

Hodgkins (686) reported it on carnation and blue grass.

F. poae occurs on a head blight of oats in the coast region of Oregon. Wollenweber determined an isolate from this material as F. poae (Sprague, 636). The culture on potato dextrose agar was buff-colored and produced many pip-shape Sporotrichum-type spores. The fungus appeared to be a secondary parasite and was usually found on sterile spikelets.

In the Northern Great Plains, F. poae is not abundant but it is sometimes isolated from the roots of Bouteloua gracilis, Bromus inermis, Panicum capillare L., P. miliaceum, and Zea mays. It is more prevalent in Minnesota, particularly northern Minnesota, on Poa pratensis, P. palustris, and Muhlenbergia racemosa. It was found associated with wooly aphids on smooth brome sheaths at Mandan, North Dakota. It occurs on timothy in Iowa (Gilman and Archer, 262).

The material in pure culture at Mandan developed white to powdery buff colonies that soon showed rosy tints. When the Sporotrichum stage is present in abundance the mycelium has a readily recognized loose powdery appearance.

Our inoculation trials show that some isolates of Fusarium poae are comparatively weak parasites or saprophytes. A few strains cause some seed rot in blue grama and millets. F. poae appears to be a relatively minor mold on Gramineae.

References: Gilman and Archer (262); Gordon and Sprague (278); Heald (313); Sprague (636, 663); Stewart and Hodgkins (686).

FUSARIUM SCIRPI VAR. ACUMINATUM (Ell. and Ev.) Wr., Pink Fusarium Mold, Secondary Rootrot.

This common pink mold causes yellow-brown lesions on the roots of some grasses and cereals but is usually associated with other fungi without any specific symptoms. It is a common saprophyte on practically all Gramineae in the western United States but causes some seed rot in spring and fall on small-seeded crops. It is only a weak parasite on wheat and barley and is apparently nonparasitic on oats.

This variety differs from Fusarium scirpi in the rose-pink, firm colony that is produced on potato dextrose agar. The mycelium tends to be coarse and breaks into characteristic stiff fragments in microscope mounts. It often produces no spores, although some isolates form carrot-red masses of macrospores slightly smaller than those of F. scirpi. Five-septate macrospores average 45 x 4.1 μ, and 7-septate, 55 x 4.3 μ. The curved spores have the typical Gibbosum shape, narrow at the apex. This fungus is readily distinguished from F. culmorum and F. graminearum by its firm felty growth with rose-pink coloration instead of the carmine and yellow-buff looser mycelium of the two scab-forming species,

F. culmorum and F. graminearum. F. scirpi var. acuminatum is the common pink Fusarium of the prairie country. Less common are F. scirpi var. compactum Wr. and F. scirpi var. longipes (Wr. and Reinking) Wr., which Gordon determined as being present in North Dakota (Gordon and Sprague, 278). The former is distinguished by closely spaced septa in the macroconidia, and the latter by its exceptionally long macroconidia.

F. scirpi var. acuminatum apparently is favored by cool wet weather in March and April when it develops on the roots of overwintering perennial grasses and on young seedlings and sprouting seeds. It is a very common saprophyte following Cercosporella herpotrichoides in the Pacific Northwest, and is one of the components of dry land rootrot of winter wheat in the Great Plains. It also occurs in acid soils in the peat area of northern Minnesota and westward, and is common in soil of relatively high alkalinity. Cultures of this fungus isolated from red soil in Wyoming were particularly pale in color and evidently were a local race. Sometimes other cultures from various areas have shown marked buff colorations but these colorations are frequently induced by bacterial associates in the cultures. The writer's inoculation trials (663) have shown considerable variation in racial traits among the isolates, some being mildly to moderately parasitic, others saprophytic or essentially so.

References: Fellows (229); Gordon (276); Gordon and Sprague (278); Sprague (663).

FUSARIUM SPOROTRICHIOIDES Sherb., Secondary Rootrot, False Scab.

This fungus is readily confused with Fusarium poae. It has the same general host range and produces Sporotrichum-type microspores. The microspores of F. poae are 0- to 1-septate, citron shape or pip shape, mostly 6.6-14 x 4.7-6.4 µ, while those of F. sporotrichioides are usually longer, 5-28 x 2.2-3.8 µ. Macrospores of F. poae are 3-septate, 18-35 x 3.5-5 µ; in F. sporotrichioides they are 3- 5-septate, 25-56 x 3.4-4.5 µ.

Fusarium sporotrichioides is sometimes isolated early in the season from roots of Gramineae in the Northern Great Plains. It occurs on the roots of blue grama, side oats grama (Bouteloua curtipendula), smooth brome, Elymus junceus, Festuca rubra, Hordeum jubatum, Panicum capillare, and P. miliaceum in the area. It disappears rather completely during the growing season, but reappears as a pink mold or false scab on wheats and barley at or near harvest time. It is a minor component of "durum blight" but appears to be saprophytic in these instances. In general, tests by the writer (Sprague, 663) indicate that F. sporotrichioides is even less parasitic than F. poae. Its chief importance lies in the fact that growers are sometimes docked for "scabby" wheat when the grain is carrying only the relatively harmless false scab organism, F. sporotrichioides. F. poae appears to be more abundant in Manitoba than F.

sporotrichioides (Gordon, 275, 276), but in North Dakota the reverse has been true during recent years. F. poae is more common in northeastern North Dakota and in northern Minnesota, thus indicating relationship to the Manitoba situation.

References: Gordon (276); Gordon and Sprague (278); Sprague (663); Wollenweber and Reinking (776).

HELMINTHOSPORIUM

This complex and important genus was well presented about 20 years ago by Drechsler (176) although his work was limited to the Eastern States. At present the genus is being re-studied in that area and to some extent in the Plains region. The work with rootrots in the Northern Great Plains (Sprague, 663), has disclosed a number of forms that need critical taxonomic study.

HELMINTHOSPORIUM AVENAE Eidam, Helminthosporium Leaf Blotch of Oats (Leaf-stripe disease of oats in Scotland (Dennis, 149).

In summer, in the Northern Great Plains, the spots on oat leaves may be poorly defined brown areas merging into yellowish red or orange lesions. In winter or in cool weather, in Oregon, they are more frequently definite spots of red or purple anthocyanin shades surrounded by haloes of yellow. As they get older, the spots fade to straw color in the center. Dennis (149) reported pre-emergence killing in seedlings from seed-borne mycelia or spores in Scotland. Survivors showed leaf stippling. Later, spotting developed, often secondarily in late season, particularly on second growth oats.

The fungus requires cool moist growing conditions such as prevail in the winter, early spring, and fall in the coast region of Oregon, Washington, and in parts of the British Isles. In Oregon, H. avenae was isolated from the bases of diseased plants but appeared to have washed down the culm and developed as an associate of H. sativum, Ophiobolus graminis, Fusarium culmorum, Pythium spp., and Aphanomyces sp., which thrived in the highly acid soil of the coastal region where the diseased condition prevailed (Sprague, 639). H. avenae is somewhat lighter gray in pure culture than most isolates of H. sativum and it tends to form bracketed growths in test tube cultures, somewhat distinct from any formed by H. sativum. The spores are very different also; they are olivaceous or paler, cylindrical or slightly swollen in the middle, rounded at the ends, 4- to 6-septate, 80-110 x 15-16 μ, borne on scattered, stout cylindrical, multiseptate, fuliginous conidiophores, 150-200 x 9-12 μ.

While this fungus causes a minor leaf spot in many places, it is very serious in Scotland and Ireland and moderately important in western

Oregon. Seed treatment with New Improved Ceresan at 1/2 oz. per bushel is very necessary where the disease is serious. Varietal resistance was not noted in Scotland although the varieties Sovereign and Ascot were particularly susceptible. In Oregon, winter-hardy oats such as Support or Gray Winter are more tolerant to the disease than less winter-hardy ones such as Red Rustproof or Kanota of the red oat group (Avena byzantina). Wild oats (Avena fatua) carries the disease in Oregon, California, and North Dakota; and it occurs also on A. barbata Brot. at San Diego, California, and on Arrhenatherum elatius on Mt. Diablo, California.

References: Dennis (149, 150); Drechsler (176); Eidam (199); Ito and Kuribayashi (354); Muskett (479); O'Brien and Dennis (491); Rathschlag (526); Sprague (639).

HELMINTHOSPORIUM BROMI Died., Leaf Spot of Brome.
(Ascigerous stage, Pyrenophora bromi (Died.) Drechs.)

Minute dark brown or black spots with a yellowish halo appear on the first leaves in early spring in the northern United States. The spots elongate, become as much as 2 x 6 mm in size and, through coalescence, may cover much of a leaf area. The leaves then become yellow, wither, and die. The fungus is favored by cool weather, with temperatures ranging from 2° C to 10° C, and becomes less conspicuous as the season advances. It is very common on Bromus inermis in North Dakota, particularly in the Red River Valley (Weniger, 760). It occurs also, more or less incidentally, on the roots of this grass in the Northern Great Plains and has been collected also on leaves of B. carinatus at Wawawai, Washington; on B. japonicus Thurb. at Alzada, Montana, and nearby in Wyoming; on B. tectorum near Underwood, Washington; and on B. rigidus near Tumwater, Oregon.

The perithecial stage, Pyrenophora bromi, is well known (Drechsler, 176). Chamberlain and Allison (100, 101) recently reported that P. bromi was an important parasite on brome in Wisconsin during cool wet spring weather. The perithecia are considered to be more important in overwintering the fungus than the conidial stage, which latter does not live over winter. Varietal resistance was noted.

References: Chamberlain and Allison (100, 101); Diedicke (163); Drechsler (176, pl. 8, 9); Weniger (760)

HELMINTHOSPORIUM CALIFORNICUM Mackie and Paxton, Spot Blotch.

The writer (639) believes that this is a form of H. sativum, similar to if not identical with material studied by the writer in Lincoln County, Oregon. Mackie and Paxton described the fungus as a leaf spot parasite of barley in central California (Mackie and Paxton, 427; Mackie, 424). In recent years the name has disappeared from current literature.

HELMINTHOSPORIUM CYCLOPS Drechs., Leaf Spot.

The spots on Danthonia californica in the Willamette Valley, Oregon, are scattered, dark brown or black, and small, usually less than 0.5 x 2 mm in diameter.

Drechsler (176, pp. 729-730, pl. 32, 33) described this fungus on D. spicata (L.) Beauv. from Lisbon Falls, Maine. The Oregon collections (Sprague, 655) represent the only other report of this fungus as far as our records show. Neither the fungus nor its host is of very much economic importance.

HELMINTHOSPORIUM CYNODONTIS Marig., Leaf Mold.

Forms an effuse olive to fuliginous blotch on dry leaves of Bermuda grass (Cynodon dactylon) in the Bay region of California and southward. Drechsler (176, pp. 719-720, pl. 27) reports it also on Eleusine indica (L.) Gaertn. and Muhlenbergia mexicana. in Florida and near Washington, D. C., and into New York state. It is practically omnipresent in the South but outside of disfiguring lawns it is not believed to cause much damage. Material seen at Davis Junction, California, in 1939 would indicate that it might be of more importance.

HELMINTHOSPORIUM DEMATIOIDEUM Bub. and Wrób., Leaf Mold.

This fungus causes a leaf mold of sweet vernalgrass (Anthoxanthum odoratum L.) in northwestern Oregon. Its parasitic nature is not known. Drechsler (176, pp. 683-685, pl. 14) reported it on Agrostis alba and A. perennans (Walt.) Tuckerm. from the Atlantic coast.

HELMINTHOSPORIUM DICTYOIDES Drechs., Fescue Net Blotch.

A leaf net blotch characterized by a minute but well defined reticulate design on brown discolorations. The lesions are numerous and extensive. The leaves eventually wither and die, usually progressively from the leaf tips.

This fungus appears to be of some importance in the Far West. It was collected at Bingen, Washington, on Festuca occidentalis Hook. and recently a trace of it was found in some material of chewings fescue from northwestern Oregon.

Drechsler (174, 176, p. 677-679, pl. 11) reported it as the most important parasite of meadow fescue (F. elatior) in the eastern United States, where it is so common that it serves as a ready means of identifying the host in its vegetative stage.

HELMINTHOSPORIUM ERYTHROSPILUM Drechs., Red Leaf Spot.

This species has not been reported from the area covered by this report, but is likely to occur in the eastern part. The report of H. stenacrum Drechs. from Iowa possibly should be rechecked with this fungus. H. erythrospilum causes a true leaf spot on Agrostis, not a mold or streak as does H. stenacrum. During moist weather, it forms numerous straw-color leaf spots with a reddish-brown border, 0.5-2.5 mm. During prolonged periods of rainy weather the spots more or less overlap, forming pseudozonate patterns. They are surrounded by a water-soaked area, which presents a halo-spot effect. After dry weather returns the leaves wither and brown.

Reference: Drechsler (184).

HELMINTHOSPORIUM GIGANTEUM Heald and Wolf, Zonate Eyespot.

This fungus was described from Texas. While it is generally confined to the southern part of the United States it occurs as far north as Michigan and Illinois. It has not been reported in the range of this article but it is likely to occur. The fungus is noted for its huge fragile conidia and for the destructive zonate leaf spot (eyespot) that it produces on many grasses, notably Bermuda grass.

References: Drechsler (176, 180, 182); Heald and Wolf (319).

HELMINTHOSPORIUM GRAMINEUM Rab., Barley Stripe.

The symptoms of this important disease are detailed by Drechsler (176). Previous to heading time, the leaves become streaked with yellow bands that sometimes traverse the entire length of the leaf. The streaks later become yellowish brown or brown and the plants die prematurely. The leaves eventually become ragged or shredded. Heads may be completely sterile and the undeveloped kernels more or less brown.

Barley stripe is not important west of the Red River Valley except in certain areas in California and scattered spots in western Oregon, and sometimes in the Palouse region of Washington and Idaho.

The use of New Improved Ceresan, 1/2 oz. per bushel, has reduced the seriousness of the disease. Infection of the seed is favored by high humidity at and following flowering time. The disease may be carried over as mycelium penetrating from the glumes into the seed coat, or it may be transmitted by conidia on the seed, or wind-borne. Infection of the seedling occurs at sprouting time and is favored by cold, wet soil.

Christensen and Graham (112) found that H. gramineum was polymorphic and multiracial. They found about 125 races showing some morphological

differences in some cases and many variations in cultural characters. About 20 races could be distinguished by their relative virulence on 16 varieties of barley.

Shands (600) found that H. gramineum was somewhat adaptable to varying temperature conditions. Barley will grow at cool temperatures (12-16° C) as will H. gramineum, but the latter also developed well at cooler temperatures and also at 20° C.

The following varieties have been more or less resistant to stripe: Glabron, Trebi, Spartan, and Wisconsin barbless.

References: Åberg (2); Arny (16); Christensen and Graham (112); Dickson (160); Drechsler (176, p. 650-656); Johnson (373); Leukel, Dickson and Johnson (404); Majdrakoff (430); Nisikado (486); Paxton (506); Reddy and Burnett (529); Shands (600); Shands and Arny (601); Smith (110); Suneson and Santoni (693); Weniger (760).

HELMINTHOSPORIUM HADROTRICHOIDES Ell. and Ev., Mold.

Medium gray, linear streaks followed by withered, sometimes shredded leaves or vague spots on dead leaves. Material, probably saprophytic, found by the writer on leaves of Eragrostis cilianensis (All.) Lk. from Miles City, Montana, was determined by C. L. Lefebvre as H. hadrotrichoides. We also isolated the same fungus from the roots of this grass growing in sandy soil at Mandan, North Dakota.

References: Drechsler (176, pp. 710-711, pl. 23); Ellis and Everhart (211); Mitra and Mehta (470).

HELMINTHOSPORIUM HALODES Drechs., Mold.

This was originally described on Distichlis spicata (L.) Greene from the Atlantic coast, but it appears to be a fairly common saprophytic mold, causing secondary seed rot or possibly rootrot in Agropyron repens and Muhlenbergia japonica Steud. in plots at Mandan, North Dakota, and in Panicum miliaceum, Poa spp., Schedonnardus paniculatus (Nutt.) Trel., Setaria italica (L.) Beauv. and Setaria viridis in North Dakota, South Dakota, and Minnesota. The symptoms produced by H. halodes are vague, dark discolored, more or less bluish areas on the leaves, sheaths and culms, also a black mold on the inflorescence. The species is not recognized as being associated with any particular rootrot symptoms.

In culture the dark spores are somewhat longer and less "kneed" than those of Curvularia geniculata although some strains are confusable, when immature, with the 4-septate phase of this species.

Mitra (468, p. 287) described H. halodes var. tritici Mitra on

root-rotted wheat from India. The conidia are cylindrical or elliptical with the distal end abruptly rounded and the proximal end tending to taper to an acute base with a prominent, protruding hilum. The spores are widest at their middle, straight or slightly curved, 2- to 9-septate (average 6), light yellowish brown to smoky brown, the two end cells being slightly lighter, 23-73 x 13-20 µ, mean 50 x 16.5 µ. The description resembles some of the material isolated from roots of various grasses at Mandan, North Dakota.

Most of the isolates of H. halodes have been saprophytes or have produced mild seed rots (Sprague, 663).

References: Drechsler (176, pp. 707-709, pl. 22, 23); Mitra (468); Sprague (663).

HELMINTHOSPORIUM INCONSPICUUM Var. BUCHLOËS Ell. and Ev., Mold.

Material that C. L. Lefebvre refers to this fungus causes a mold on withered leaves of Buchloë dactyloides, Bouteloua gracilis, and B. curtipendula in the Northern Great Plains. The mold is associated with vague, brown blotches and is sometimes isolated from roots of older plants.

Pammel, King, and Bakke (502) illustrated H. inconspicuum var. buchloës as having small, heavy-walled spores. Technically the fungus apparently is undescribed (nomen nudum). Nothing is known about its economic importance.

References: Pammel, King, and Bakke (502).

HELMINTHOSPORIUM MONOCERAS Drechs., Spotblotch.

Forms dark brown or chocolate color spots, 0.3-1 x 1-3 mm, on the upper leaf blades. The lower leaves become withered and are covered with similar, larger elliptical spots, sometimes 1.5 x 5 mm. The older spots on the dead leaves are faded to a dull medium brown. The leaf sheaths and the tissue at the base of the plants are a diffuse brown. Conidiophores appear after the death of tissue.

This fungus occurs on barnyard grass (Echinochloa crusgalli), but a similar fungus has sometimes been isolated from the roots of Panicum miliaceum and of Setaria viridis in the Northern Great Plains. (See also H. setariae Saw.).

The spores are yellowish when young but later darken to the same color as those of H. sativum, thus contrasting with the much paler ones of H. turcicum Pass. The spores are 40-150 x 15-22 µ, typically straight, and usually widest at the middle segment, gradually tapering toward the tip to

1/3 or 1/2 of the maximum width, then bluntly rounded, tapering towards the base to approximately 1/6 of the median diameter, the contours then curving gently into the protruding hilum, 3- to 10-septate, scarcely constricted.

Schweinfurth and de Thuemen (588) list H. flexuosum Cda. (Brachysporium flexuosum (Cda.) Sacc. on the culms and inflorescence of Echinochloa crusgalli in Egypt. Possibly this is the same fungus as Curvularia trifolii mentioned earlier in this article.

An undetermined species of Helminthosporium is listed from the vicinity of Sydney, Australia, on E. crusgalli (Noble et al., 488).

References: Drechsler (176, p. 704-707, pl. 20, 21); Noble et al. (488); Schweinfurth and de von Thuemen (588).

HELMINTHOSPORIUM POAE Baudyš, Mold.

Somewhat fragmentary material on Poa trivialis L. from Astoria, Oregon, (O.S.C. 10,330) and on Poa secunda from Klickitat County, Washington (O.S.C. 4) did not appear to belong in H. vagans Drechs. and was assigned with considerable hesitation to H. poae (Baudyš, 24), a little known species described from central Europe. According to a footnote by Drechsler (176, p. 688) this fungus has 2- to 6-septate spores, 36 to 73 µ long. The spots are yellowish with a dark brown margin. Drechsler compares his H. vagans not only with H. poae but also with Napicladium gramineum Pk., which latter is a synonym of Scolecotrichum graminis Fckl. (Sprague, 657). H. poae certainly needs critical study. Possibly it too may have some well known earlier name.

References: Baudyš (24); Drechsler (176, p. 688); Sprague (637, 655-657).

HELMINTHOSPORIUM SATIVUM Pam., King, and Bakke, Spotblotch, Rootrot, Seedling Blight, Black Point, and Dryland Rootrot.

The seedling phase of the disease is characterized by a slow, dark rot of the coleoptile region with injury spreading later to the cortex and small feeder roots. The seedlings of small grasses may be wiped out early or even killed before emergence (pre-emergence blight), but the injury is less spectacular than that caused by Pythium arrhenomanes. Such hosts as barley, which show stunting or killing of lower leaves, very often recover later with slight apparent ill effects if growing conditions are optimum for the host.

After the seedling phases have been passed, leaf spotting may occur. This is a brown blotch rather than a definite spot or stripe. Abundant spotting in late season on barley or wheat speeds up premature ripening of the grain. The fruiting bodies of the fungus may give the maturing

plants a blotchy or olivaceous cast. Barley seed and glumes show dark brown stains that are accompanied by shriveling of the kernels. The basal portions of kernels are more likely to be discolored. Black point of wheat and other grains is partly due to H. sativum, and most of the injury that occurs at seeding time in the Northern Great Plains from seed-borne parasites is due to this fungus.

In winter wheat, injury due to Helminthosporium sativum is vague, particularly on wheat grown in the semi-arid regions. The more or less recognized term, "dryland rootrot" (or footrot), is used to designate a particularly vague type of injury in which the plants show pronounced stunting in more or less circular to irregular areas in the fields. The crowns of these plants, when bisected with a sharp knife, uniformly show a conical area of brown, prematurely dead or necrotic tissue. These areas of greatest injury are frequently associated with shallow soil, hard pan under layers, or other conditions unfavorable for the growth of the plant. In the dry, winter wheat regions, occasional white heads (sterile heads) develop in winter wheat showing dryland rootrot. These are particularly common in eastern Oregon and are a phase of premature killing of plants by the almost omnipresent H. sativum.

Helminthosporium sativum occurs on many hosts, but it is most important as a rootrot and kernel smudge or blight of wheat and barley. It has been reported on dozens of species of grasses as well as on oats, corn, and wheat relatives. In the Northern Great Plains, it has been isolated from the roots of 79 species of Gramineae. It is especially common on species of Elymus, Agropyron, Bromus, and Hordeum, and less abundant on species of Poa, which are resistant to some extent. The host range as established by seedling and seed inoculation trials in the greenhouse is very extensive.

H. sativum is world-wide in distribution in the temperate zone. It occurs in very acid soil (pH 4.8) in a region of very heavy rainfall (70-100 inches yearly) in Oregon, and is omnipresent in the arid and semi-arid parts of the western United States. While it is an important parasite of wheat and barley, it takes second place as a parasite of grass roots when compared with Pythium arrhenomanes. Its importance on grasses may have been somewhat exaggerated in the past. However, because it is so universally distributed, it cannot be dismissed as a minor parasite even on grasses.

As a component of dryland rootrot of fall-sown wheat, it is not considered as important as it is on spring grain. Its effect is, nevertheless, important in spite of its obscure nature.

Helminthosporium sativum has been studied in great detail by a number of workers. Christensen has shown that it possesses a large number of physiologic races; also, it is generally recognized as being readily influenced by environment. Changes in light or moisture, or the presence or absence of antagonists can change a single isolate to almost

unrecognizably different sub-cultures. While H. sativum is able to thrive in cool and moist weather, often it causes greatest injury in drought periods that follow. The diseased plants have weakened root systems and are unable to supply the plant with water and nutrients as readily as do healthy plants with larger root systems.

Seed treatment (New Improved Ceresan, 1/2 oz. per bushel) is effective insofar as it destroys seed-borne H. sativum on cereals but soil-borne spores and mycelium are scarcely affected by seed treatment.

References: Andrews (14); Beckwith (30); Bolley (56); Brentzel (65, 66); Broadfoot (69, 71, 72); Broadfoot and Tyner (74, 75); Christensen (106-109); Christensen and Davies (110, 111); Christensen and Stakman (113); Dosdall (172); Dosdall and Christensen (173); Drechsler (176, pp. 690-704, pl. 17-19); Greaney (284); Greaney and Bailey (285); Greaney and Machacek (286); Greaney, Machacek and Johnston (287); Greaney and Wallace (288); Gries (292); Hanson and Christensen (308, 309); Henry (321, 322); Hynes (345, 348, 349); Johnson (372); Kuribayashi (394); Ledingham (399); Machacek (418); Machacek and Greaney (421); McKinney (445, 446); Mead (453, 454); Mitra (467, 468); O'Gara (492); Pammel, King, and Bakke (502); Pinck and Allison (516); Richardson (535); Russell (550); Russell and Ledingham (551); Russell and Sallans (552); Sallans (563-567); Sanford (578); Sanford and Broadfoot (580); Sanford and Cormack (581); Simmonds, Russell, and Sallans (611); Simmonds and Sallans (612, 613); Smith (615); Sprague (639, 654, 655-661); Stakman (679); Stevens (683, 684); Stover (689); Tropova (712); Tyner and Broadfoot (724); Valleau (734); Weniger (760); Ziling (780).

HELMINTHOSPORIUM SETARIAE Saw., Spotblotch and Secondary Rootrot.
(H. setariae Lind)
(Ascigerous stage, Ophiobolus setariae Ito and Kuribay.).

This species is sometimes isolated from the roots of Setaria viridis and less frequently from S. italica in North Dakota. In Japan (Ito and Kuribayashi, 354) the fungus produces abundant dark brown spots or leaf blight. In North Dakota such spotting is less common but in the late season it frequently occurs, mixed with spots caused by H. sativum.

In the description of Ophiobolus setariae Ito and Kuribayashi (354), the conidial stage, H. setariae, is listed as having dark olivaceous spores that are fusiform, obclavate ellipsoidal, mostly somewhat curved, slightly broader at or somewhat below the middle, tapering towards both ends, 5- to 10-septate, 40-120 x 10-18 μ, with fragile walls.

Pure cultures resemble H. sativum macroscopically but the spores are narrower than those of H. sativum. A. G. Johnson determined New Jersey material (Haenseler, 302) as belonging to H. setariae. It was some leaf spot material on Setaria italica, collected at Beltsville, Maryland, sent by Dr. Johnson that permitted determination of Mandan and North

Dakota material as H. setariae, and not as H. turcicum to which the writer had been inclined to assign it. Inoculation trials at Mandan show that H. setariae, when added as a sand-bran inoculum to electrically sterilized soil, is somewhat pathogenic to Setaria spp., Echinochloa crusgalli, Panicum miliaceum, and Bouteloua gracilis, but is less parasitic on Triticum aestivum and Agropyron cristatum, and only moderately parasitic to Sorghum vulgare L. Indications at present are that the fungus is not important in North Dakota.

References: Elveden (218); Haenseler (302); Huang (342); Ito (353); Ito and Kuribayashi (354); Lind (408); Sawada (583).

HELMINTHOSPORIUM SICCANS Drechs., Brown Blight.

The leaf blight of Lolium perenne and L. multiflorum caused by this fungus is very common in the Willamette Valley, Oregon, in winter and in early spring. It is particularly prominent on uncut lawns, where the leaves in certain areas are nearly all killed back to their bases. The leaf spots are numerous, dark brown, measuring 0.1-0.3 x 0.2-1 mm, and so abundant that much of the leaf surface may be covered with a pseudo-reticulate scorching or browning.

The conidia of H. siccans are never dark olivaceous, as in H. sativum, but are subhyaline or light fuliginous, later becoming yellow, brownish, or brownish olivaceous. The spores are typically straight or slightly curved, usually subcylindrical or tapering slightly or markedly toward the apex, 35-130 x 14-20 μ.

H. siccans is one of the most important diseases of L. multiflorum in the eastern United States (Drechsler, 176, pp. 679-682, pl. 12). Diedicke (164) reported a species of Helminthosporium on L. perenne. H. siccans occurs also in Scotland (Dennis and Foister, 152, p. 274) and England (Sampson and Western, 571).

HELMINTHOSPORIUM STENACRUM Drechs., Leaf Mold.

The symptoms are indefinite and the conidiophores develop on withered leaves. Oregon material on Agrostis tenuis appears to be saprophytic. H. stenacrum is reported on A. alba from Iowa.

The spores in this species are subhyaline to yellowish, 53-135 x 15-23 μ, subcylindrical with hemispherical or hemi-ellipsoidal ends, or widest somewhat below the middle and tapering moderately towards the ends. The apical portion of the spore is sometimes narrowed and prolonged. The spores are 1- to 11-septate, scarcely or not constricted at the septa, the peripheral wall is thin and the dark hilum is included within its contour (Drechsler, 176, pp. 682-683). Usually it will not sporulate on nutrient agar.

HELMINTHOSPORIUM TERES Sacc., Net Blotch.
(Ascigerous stage, Pyrenophora teres (Died.) Drechs.)

The dark brown spots or streaks on barley leaves are about 1 mm long, at first, finally 20 to 25 mm long but narrow. Some streaks of brown pigment occur transversely that break the pattern into a dark brown reticulate design within the area of diffused brown, hence the term "net blotch". The blotch tends to form near the leaf tips. These blotches may sometimes occur on the hulls.

Net blotch usually is a minor disease; although widespread it is seldom serious. It is not common in the Far West, and is most frequent in the northern United States east of the Great Plains.

The spores of H. teres are similar to those of H. avenae, subhyaline at first, later greenish fuliginous or yellowish brown but lighter than in H. gramineum, thin-walled, with a retracted hilum, 1- to 10-septate, 30-175 x 15-22 µ.

Partial control is obtained by treating seed with New Improved Ceresan, 1/2 oz. per bushel, or by reducing the number of overwintering perithecia by sanitation methods.

References: Atanasoff and Johnson (19); Böning and Wallner (59); Drechsler (176, pp. 656-663, pl. 2,3); Johnson (367); Ravn (527).

HELMINTHOSPORIUM TETRAMERA McKinney, Rootrot and Mold.

McKinney (446) described this species as the cause of a mild rootrot of wheat in Texas. Conidiophores are dark olivaceous to brown, simple or compound, with septa 5 to 50 µ apart and with the conidia produced at irregular intervals. Conidia are chiefly 4-celled, borne in clusters of 2 to 3 to 50 or more, dark olivaceous to brown, usually rather symmetrical in shape, tapering towards the rounded ends, 20-41 x 10.2-20.4 µ, frequently 30-34 x 10.2-13.6 µ.

The writer has isolated a similar fungus from cereals and grasses in North Dakota, South Dakota, Montana, Wyoming, and Nebraska. The spores on potato-dextrose agar are dark olive smoky, relatively thin-walled, regularly elongate, elliptical, 3-septate, 23-31 x 8-12 µ, borne on simple or sparsely branched conidiophores. A number of attempts to produce rootrot lesions or even seed rot on various Gramineae with this fungus have been unsuccessful. The local fungus appears to be Brachycladium spiciferum according to a letter received from J. E. Machacek in 1941. B. spiciferum was transferred to Curvularia spicifera (Bainier) Boed., but without much justification as the regular elliptical spores are not in the least Curvularia-like. The fungus has small spores but could be placed in Helminthosporium or Brachysporium,

according to Machacek. He believes that B. spiciferum differs from H. tetramera. The spores of the former may be smaller than in H. tetramera, and the non-parasitic nature of the former may indicate specific differences between the two. In our case we question whether H. tetramera proper has been found in the Northern Great Plains.

Brachycladium spiciferum is usually isolated from overwintering roots and crowns of perennial grasses and from roots and sprouting seeds of grasses and cereals in the early season and late fall. It produces a luxuriant dark gray-black colony on potato-dextrose agar. Spores are produced in moderate quantities but seldom in large numbers. McKinney stated that H. tetramera produced long, simple, or branched sclerotia composed of hard white pseudoparenchyma with an outer black layer or rind. Many hyphal strands developed from these rinds, but no conidia were found on them. However, McKinney did have conidia in pure culture, as he stated earlier, and there seemed to be little if any change in spore characters when the fungus was cultured artificially. Since B. spiciferum produces a readily growing gray-black cottony colony that resembles Alternaria tenuis Nees and shows none of the sclerotial development of McKinney's cultures, the two forms are possibly distinct. Machacek mentioned in a letter to the writer (May 2, 1941) that he had seen material on oats and barley from eastern Canada that is closer to H. tetramera than to B. spiciferum, although, as he points out, Hynes (348) has referred Australian material to C. spicifera while Mason has referred it to H. tetramera. The tendency during recent years appears to be to lump the two species together. While no critical taxonomic report is available, the group had been under study by Machacek, until current economic conditions interfered. Crosier and Weimer (132), who also had the aid of Machacek, concluded that C. spicifera was a saprophyte, although they did obtain mild seedling injury on Poa pratensis, P. compressa, P. trivialis, and Agrostis alba (A. palustris). Machacek points out in his letter to the writer that in Crosier and Weimer's paper the legends on the illustrations of C. spicifera and C. geniculata are transposed. Thomas (706) also failed to obtain injury with H. tetramera (C. spicifera). In 1937 (Anonymous, 1), B. spiciferum was reported as an associate of R. solani in a brown patch of lawns in New South Wales. Bensaude (40) obtained consistently negative results on wheat in Portuguese East Africa with a fungus also referred to H. tetramera. Some further study with the Texas material is indicated as being desirable.

References: Anonymous (1); Bensaude (40); Crosier and Weimer (132); Hynes (345, 348); McKinney (446); Thomas (706).

HELMINTHOSPORIUM TRISEPTATUM Drechs., LEAF MOLD.

This causes a gray mold on dead or withering leaves of Holcus lanatus in the humid parts of coastal Oregon and Washington. It was also found on moldy leaves of Agrostis exarata at Wells (now Camp Adair), Oregon.

In New York, Horsfall (349) reported leaf tip killing on Agrostis alba and orchard grass. Drechsler points out the contrast between the vague lesions caused by this fungus on red top (A. alba) and the definite leaf spots caused by H. erythrospilum (Drechsler, 184).

The spores of H. triseptatum are dark, olivaceous, ellipsoid or short cylindrical with hemispherical ends, 2- to 3-septate, 35-50 x 15-21 μ. The peculiar thickenings of the conidiophores, as shown by Drechsler, are diagnostic (Drechsler, 176, pp. 685-686, pl. 14).

HELMINTHOSPORIUM TRITICI-REPENTIS Died., Leaf Blight.
(Ascigerous stage, Pyrenophora tritici-repentis (Died.) Drechs.

Drechsler (176, pp. 667-670, pl.5-6) describes the symptoms on Agropyron repens as being vague, manifested in a gradual fading and necrosis of the leaves, which finally become gray and heavily covered with conidiophores and later with perithecia, particularly on dead culms. In Oregon, definite brown to fuliginous spots and streaks occur on the leaves of A. repens and these are followed later by general necrosis. On Elymus hirsutus Presl the dark brown spots were very abundant on all the leaves of some plants along the Santiam River, Oregon, in May.

In the Northern Great Plains saprophytic development is sometimes great on wheat leaves during rainy periods in later season; however, little evidence has been seen of parasitic activity in this region. On wheat the fungus is usually associated with Septoria nodorum and other fungi. Fungi similar to H. tritici-repentis are isolated occasionally from the roots of cereals and grasses in the Northern Great Plains. Isolates from the roots of crested wheatgrass cause preemergence injury in crested wheatgrass, blue grama, proso, Italian millet, Japanese millet, and slight rootrot in wheat (Sprague, annual report, manuscript, 1944).

The conidia are subhyaline, straight cylindrical, 1- to 9-septate, 45-175 x 12-21 μ. Drechsler (176) states that "the most distinctive peculiarity....is found in the shape of the basal segment which.....in profile is remotely suggestive of the horizontal aspects of the head of a snake, while the distal end usually is rounded off in hemispherical form."

References: Barrus (22); Conners (121); Drechsler (176); Johnson (369); McRae (452); Mitra (469); Nisikado (486); Raabe (517).

HELMINTHOSPORIUM TURCICUM Pass., Leaf Blast, Seed Rot.
(H. inconspicuum Cke. and Ell.)

A gray-green leaf blight of corn was seen in some experimental plots

in Lincoln County, Oregon, some years ago, and it occurs also on Sorghum vulgare var. sudanense in California. H. turcicum is otherwise unreported west of the Rockies. Chilton (104) reported H. turcicum on seeds of sudan grass from South Dakota, while the writer has isolated the fungus from the roots of corn and sorghum in North Dakota at various times.

The conidia are typically subhyaline to yellowish brown, very thin-walled, straight or slightly curved, widest near the middle and tapering decidedly towards the ends, somewhat cone-shaped at the hilum end, with the apical end rounded off but not beaked, 1- to 8-septate, 45-140 x 15-25 µ. The hilum scar is minute but it is distinctly protruded. The fungus develops a luxuriant gray-black aerial mycelium on potato-dextrose agar.

This fungus depends on high humidity, long rainy periods, and a maturing host for its most severe action. Because it develops in late season, its effect is often more spectacular than serious. Sherbakoff and Mayer (604) reported a black ear rot of corn as due to H. turcicum in Tennessee, but no doubt it is H. carbonum (Ullstrup, 729). Chilton has shown that H. turcicum is seed-borne on sudan grass and potentially destructive. The disease is considered to be serious in the Tropics and it interferes with seed production in the United States, particularly in sweet corn plantings in the East. Its importance on the roots of corn, sorghum, sudan grass, proso millet, and species of Setaria in North Dakota is slight. The identity of these forms remains in doubt. Some of them are atypical for H. turcicum.

Sanitary measures that reduce inoculum help to control this disease. Ducomet (187) recommended wider spacing to increase aeration. Seed treatment with New Improved Semesan Jr. kills seed-borne spores. Recent work by Ullstrup (727-729) evidences the complexity of the Helminthosporium problem on corn.

References: Campi (90); Chilton (104); Drechsler (176, pp. 712-718, pl. 24, 25); Ducomet (187); Ellett (203); Elliott and Jenkins (205); Gentner (260); Lefebvre and Sherwin (401); Mitra (466); Nisikado (485); Nisikado and Miyake (487); Reinking (531); Sherbakoff and Mayer (604); Ullstrup (727-729); Valleau (734); Zhavoronkov (799).

HELMINTHOSPORIUM VAGANS Drechs., Bluegrass Leaf Spot.

The leaf spots are circular to elongate with prominent reddish-brown borders darkening to nearly black in the center and, later, some becoming lighter in the center. Occasionally the spots are prevalent, particularly near the crown, but sometimes they are scattered over the upper leaves.

The disease occurs on Poa compressa but is most abundant on Poa pratensis. It also occurs on Poa arida Vasey in plots at Mandan, North

Dakota. It is seldom serious in the Pacific Northwest, and even less so in most of the Northern Great Plains, but appears to be definitely more important from Minnesota and Iowa eastward.

Since H. vagans is favored by rainy weather it develops most actively during late winter and early spring in the Pacific Northwest and during late summer and fall in the Northern Great Plains. At Mandan, North Dakota, moderate injury occurs during September or even October.

Horsfall (340) found that copper-lime dust inhibited this fungus.

References: Drechsler (175, 176, p. 686-688, pl. 15); Horsfall (340); Sampson and Western (571); Sprague (657).

HELMINTHOSPORIUM SPP. on Various Hosts.

In addition to the instances cited a number of collections were either too fragmentary or too recently seen to justify cataloguing. Most of these collections have been forwarded to A. G. Johnson and C. L. Lefebvre for study.

The following are included in undetermined material:

Helminthosporium (catenarium Drechs.) on Beckmannia syzigachne (Steud.) Fern., from West Fargo, North Dakota, June 20, 1944. Mingled with various leaf molds and Physoderma sp.

Helminthosporium sp. on Sporobolus neglectus Nash, Mandan, North Dakota, September 4, 1944.

Helminthosporium sp. on Gastridium ventricosum (Gouan) Schinz and Thell., a fragment from the southern part of the Willamette Valley, Oregon, showing a small circular white leaf spot.

Helminthosporium sp., a leaf blotch on Muhlenbergia asperifolia from Ft. Totten, North Dakota.

The isolates from the roots of warm season hosts including Panicum spp., Setaria spp., sorghums, and corn need further study. No doubt most of the isolations from Setaria that are not assignable to H. sativum belong in H. setariae, but some few are close to H. turcicum. Most of these forms are distinctly less parasitic than H. sativum.

HETEROSPORIUM AVENAE Oud., Leaf Mold.

This mold is not uncommon on overwintering plants. While it is usually saprophytic, the writer has seen material on Avena sativa from Oregon;

on Elymus condensatus from Oregon and Washington, and from Jackson, Wyoming, and on Phalaris arundinacea from Nebraska, that appeared to show evidence of parasitic activity on the part of Heterosporium avenae. It is usually found in the early season. Conidiophores of this fungus on western material resemble those of Scolecotrichum graminis Fckl., but the cylindrical spores are echinulate.

Solheim (617) reported Heterosporium avenae on leaves, stems, and spikes of wheat from Laramie, Wyoming, collected in August 1930. The writer noted it on leaves of overwintering wheat in Klickitat County, Washington, some years ago. A similar species was also seen on leaves of Bromus carinatus from Mt. Hood, Oregon.

HETEROSPORIUM PHLEI Greg., Leaf Spot.

The spots on Phleum pratense are small, oval, 0.5 to 1 mm wide and 1-4 mm long, rarely larger. The center of the spot is light mauve, with a narrow madder-violet or dark nigrosin-violet margin fading to brown or sometimes intensifying to black. Sometimes intervening tissue becomes yellow, and severely infected leaves may die. The scattered, sharply defined spots usually distinguish this parasite from other spots on timothy. Spores are rarely produced in the field. The conidia are 1- to 6-celled, chiefly 1-septate, not constricted at the septa, echinulate, pale to dark brown, 13-57 x 6-14 μ, averaging 23 x 9 μ.

Jacques (359) found that the fungus grew rapidly on potato-dextrose agar. The colony was bordered by a white margin, surrounding the olive-green center in the outer portion of which four or five zones of different shades of green could be recognized. A certain amount of white aerial mycelium gave the center a grayish tinge. The medium showed a reddish or purplish coloration for some distance around the margin of the colony.

In the original description, Gregory (291) reported that the fungus grew slowly in pure culture and did not sporulate until a thallus of considerable size was formed. Jacques (359), working with this strain, found thatthe fungus produced spores abundantly in pure culture after only 4-5 days when the thallus was only 12 mm in diameter.

Jacques stated that Heterosporium phlei is possibly merely a physiologic race of some earlier-described species, such as H. avenae Oud., H. graminis McAlp., H. hordei Bub. or H. phragmitis Sacc.

Heterosporium phlei occurs on timothy in Oregon, Washington, and Idaho to a limited extent, particularly in prairie areas and along the coast where the rainfall is moderate to heavy. It is more prevalent in Minnesota and appears to be important at times in New York and in the Eastern States in general. The spores are able to germinate at from 3° to 33° C, with the optimum at 24° C. Since the disease has

been noted in February, March, July, and August, the fungus is evidently adaptable to a wide range of temperature. H. phlei also occurs on Phleum phleoides (L.) Karst. at Pullman, Washington.

Horsfall (340) indicated that relatively satisfactory control could be obtained with Kolodust and somewhat less control with 300-mesh dusting sulfur. In most instances it would not pay to dust for this leaf spot alone.

References: Gregory (291); Horsfall (340, fig. 18, 19); Jacques (359).

MASTIGOSPORIUM SPP.

Key to species:

A. Spores with apical appendages .... M. album Riess (Not reported from U. S.)

AA. Spores muticate, 3-septate

B. Spores 25-32 x 4.5-5.9 µ .... M. cylindricum Sprague

BB. Spores 29-90 x 9-17 µ .... M. rubricosum (Dearn. and Barth.) Sprague

Most keys include only Mastigosporium album, which is readily traceable by its simple or forked, elongate, hyaline apical appendages, and for anyone not familiar with the large clear hyaline, 3-septate, cylindrical spores of M. rubricosum its determination is likely to be difficult with any available keys.

MASTIGOSPORIUM CYLINDRICUM Sprague, Brown Spot.

This very distinct species is known only from a restricted forested area in the Coast range of Oregon, on Bromus vulgaris. The brown spots are elliptical to elongate, finally confluent and mottled. The mycelium is mostly endophytic, somewhat coalesced beneath the upper leaf surface, coarse, hyaline or lightly tinted, producing short, stout conidiophores from which spores are developed by expansion of the distal portion and eventual abscission.

Reference: Sprague (648, fig. 1,b).

MASTIGOSPORIUM RUBRICOSUM (Dearn. and Barth.) Sprague, Eye Spot. (*M. calvum* (Ell. and Ev.) Sprague).

On *Dactylis glomerata*, dark purple brown flecks are formed, which enlarge and become elliptical spots with ashy-gray to fawn color centers, 1-8 mm long, somewhat restricted by the parallel leaf veins. Larger lesions show various shades of gray, ashy, or light fawn color with more or less purple, red, or ochre borders.

On species of *Agrostis*, the lesions usually are broader, elliptical, light brown with fawn centers, becoming an eyespot or frogeye spot with a broad red, or red and yellow margin.

On *Calamagrostis* and *Trisetum* the lesions are the same as on *Agrostis*, or are small brown flecks, 1- to 3-mm in diameter, with small gray centers, or are sometimes surrounded by fawn or pale buff-color tissue.

The large navicular, crystal hyaline, 3-septate conidia are formed by expansion of the hyphal tips. They differ from *M. album* in the complete absence of the simple or forked aseptate filiform apical appendages.

In the humid parts of Oregon, Washington, and Alaska, this is one of the most serious leaf spots, being particularly destructive to orchard grass, red top, and creeping bent (*Agrostis palustris*), and in the mountains it is very abundant on *Calamagrostis canadensis*.

This fungus develops during open winter weather in Oregon and Washington, and during rainy or foggy weather throughout the growing season. High humidity and dense stands favor its development. In Oregon it occurs commonly on lawns in late winter.

The Oregon fungus from *Agrostis alba* was found to be a distinct race from that on *Dactylis glomerata* (Sprague 640, 648). There also are differences in susceptibility of several species of *Agrostis* to the fungus (Sprague, 640).

References: Bondarzeva-Monteverde (58); Dennis and Foister (152, p. 276; Sampson and Western (570); Sprague (640, 648).

NAPICLADIUM ARUNDINACEUM (Cda.) Sacc., Black Leaf Mold.

This black leaf mold of *Phragmites communis* has been reported from Nebraska, and material from Pelican Rapids, Minnesota, and Devils Lake, North Dakota, collected by the writer, appears to be this species. Large streaks or coalesced areas form on the leaf tips of growing plants, sometimes apparently killing considerable tissue. Yellow or necrotic areas on some leaves indicate that the fungus possibly may be somewhat systemic. There does not appear to be very much written on

this fungus. It is evidently not uncommon in marshy areas in Minnesota and North Dakota.

NIGROSPORA ORYZAE (Berk. and Br.) Petch, Dry Rot of Corn.
(Basisporium gallarum Moll.)

This is mainly a cob rot of corn. The cob tends to shred at the base or shank and sometimes the kernels are somewhat shriveled. Infected ears show black spores around the area where the ear was broken from the shank or at the base of kernels. Yellow kernels are often bleached or discolored yellow brown. The fungus may attack injured seed and rot it in the soil if the soil remains cold and wet after planting.

References: Durrell (191); Koehler (385); Mason (438); Reddy (528); Savulescu and Rayss (582, 582,a); Standen (680, 681).

OVULARIA HORDEI (Cav.) Sprague, Leaf Spot.
(Ophiocladium hordei Cav.)

In Europe this fungus causes an obscure spot on the leaves of barley, but in Wisconsin (Davis, 143, 144; Greene, 289), South Dakota, and Wyoming it occurs on the leaves of Phalaris arundinacea. In material collected along creeks in the Black Hills, South Dakota, and adjacent Wyoming village of Moxee, the writer noted prominent straw color to buff, later pale brown spots, which finally became covered with the chalky fruiting material of the fungus. The spots were amphigenous, elongate, striate, often 1-2 x 10-30 mm in diameter, finally more or less confluent and covering or killing most of the leaf surface. The spots were emarginate or were surrounded by a diffuse yellow-buff area. The conidiophores were in compact fascicles in neat rows between the veins of the leaf, emerging from stomata and arising from abundant yellow to mostly hyaline compacted or serpentinous hyphae. The conidiophores were 3-4.5 µ in diameter, 20-40 µ tall, tortuous, twisted or remarkably serpentinous particularly at the apex. The conidia were produced near the apex on the side of the conidiophores and, on breaking off, a slight hilum was left at the base of the elliptical to elongate ovate spores. The spores were hyaline, one-celled with an evident wall which appeared faintly roughened, 11-15.5 x 6-7.8 µ.

Jørstad (376) mentions that Ophiocladium hordei produces dark spots, bearing a white or pale pink coating produced by the conidiophores on barley leaves.

References: Cavara (99, p. 26); Davis (143, 144); Greene (289, p. 89); Jørstad (376); Sprague (666).

OVULARIA LOLII Volkart, Eyespot of Lolium.

The spores of this fungus are ellipsoid to ovoid-piriform, 15-18 x 10-11 µ, rarely 10-19 x 7-13 µ, borne in ashy spots with reddish borders. The size of the spores would indicate that this species is different from O. pulchella (Ces.) Sacc. but the writer referred one of his meager Oregon collections on L. perenne to O. pulchella and another to O. lolii, indicating that both species occur on this host, or more likely, that both belong in one variable species. The status of O. pulchella var. lolii-italici Ferr. has not been determined.

References: Saccardo (558, v. 18, p. 531); Sprague (627, 655).

OVULARIA PULCHELLA (Ces.) Sacc., Leaf Spot.

This fungus causes scattered spots on leaves and culms of Agrostis alba, A. palustris, Arrhenatherum elatius, Festuca megalura Nutt., F. myuros, Holcus lanatus, and Lolium marschalli Stev. in western Oregon, on Agrostis alba and A. tenuis in Utah, and on Bromus carinatus and Glyceria elata (Nash) Hitchc. in southwestern Washington.

The spots are usually elliptical. Those on fescues are brown or tan color, often on the stem or sheath; those on brome are gray; those on species of Agrostis, Lolium, and Holcus are red bordered, of an eyespot type. Except on annual fescues, the disease is seldom common. Fescue grasses that are growing in thick stands in sandy or open-wooded areas sometimes have a considerable percentage of the plants showing one to several spots.

Ovularia pulchella (Ces.) Sacc. (558, v. 4, p. 145) was originally described as Ramularia pulchella by Cesati (99a), and its description later amplified by Fresenius (239) as causing a purple leaf spot of Dactylis glomerata. The spores are few, crystal hyaline, ovoid, 8-12 µ long. Davis described O. pulchella var. agropyri J. J. Davis on Agropyron trachycaulum (A. tenerum) from Wisconsin (Davis, 141) as having spherical to oval spores 9-12 x 6-9 µ. Later he appeared to have considered this as being scarcely distinguishable from the species proper (Davis, 144, p. 102). See also O. pusilla (Ung.) Sacc. (558, v. 4, p. 140).

References: Cesati (99a); Davis (141, p. 714; 144, p. 102); Fresenius (239); Saccardo (558, v. 4).

PENICILLIUM SPP., Seed Rots.

Corn, sorghum, and to some extent wheat, Agropyron cristatum, and other grasses are injured in the soil before emergence by reduction in the

starchy content of the seeds before the seedlings are developed. Most of the injury occurs during prolonged rainy periods in April or May (and in 1942 even into June) in the Northern Great Plains, or earlier in the Pacific Northwest. Penicillium expansum Lk. em. Thom is the most common blue mold on these seeds, but a green mold caused by P. oxalicum Currie and Thom (133) appears to be an important species on seed corn in the Middle West. This species invades the embryo, causing yellowing of the leaves of the seedling and a gradual dying and drying of infected seedlings before the sixth leaf has unfolded (Johann, 363; Johann et al. 366). The dead plants, which remain stiffly upright, show little or no decay of the roots. The fungus is essentially a saprophyte. The injury is apparently due to oxalic acid, which kills the plant tissue in advance of the fungus.

Seed treatment (New Improved Semesan Jr.) will help reduce the endosperm-destroying molds. Proper curing of corn seed is necessary. In the drier parts of the Northern Great Plains, seed molds usually are less important and if clean local seed is used, seed treatment of field corn does not often show any benefit. However, sweet corn and pop corn usually show definite benefit from seed treatment in this area.

References: Currie and Thom (133); Diachun (157); Johann (363); Johann et al. (366); Leukel and Martin (405); Marchionatto (433); Noll (489); Thom (705).

PIRICULARIA GRISEA (Cke.) Sacc., Blast.

Gray, ashy or water-soaked spots are formed on the leaves and culms. The conidiophores rise from the stomata in groups of 2 to 5, are simple or rarely branched, fuliginous, septate, and bear conidia in terminal scorpoid cymes. The conidia are ovate, 2-septate, 24-29 x 10-12 μ.

P. grisea is common on Setaria millets in North Dakota and South Dakota and also occurs on certain other hosts in the United States. It is not important in the Northern States, as it is in the warmer regions. The closely related, if not identical, P. oryzae Briosi and Cav. on rice (Oryza sativa L.) has been intensively studied by the Japanese.

References: Schwartze (587, p. 120, figs. 735, 736); Tanaka (698).

RHYNCHOSPORIUM SPP.

Key to species:

Conidia apically obliquely-beaked...... R. secalis (Oud.) J. J. Davis

Conidia cylindrical......................... R. orthosporum Caldwell

RHYNCHOSPORIUM ORTHOSPORUM Caldwell, Scald.

The spots on the leaves are lenticular at first, coalescing to form irregular water-soaked lesions, which later become gray, surrounded by a brown margin. In some cases, on Dactylis glomerata, the spots fade to light straw color.

The fungus is very destructive on Alopecurus pratensis L. at Corvallis, Oregon. It is moderately common on D. glomerata in that region, and occurs there on Agrostis alba, Elymus glaucus, Lolium perenne, and L. multiflorum also. While R. orthosporum differs distinctly from R. secalis in the absence of an oblique beak at the apex of the spore, there are sometimes collections in Oregon that are more or less intermediate between the two species. Both species occur on L. multiflorum.

R. orthosporum occurs on Calamagrostis canadensis in the Yellowstone National Park, Wyoming, and along Spearfish Creek in the Black Hills, South Dakota. Therefore, adding Caldwell's type on D. glomerata from Wisconsin, the fungus is scattered well across the Northern United States.

The material on Elymus glaucus, restricted to an area in Linn and Marion Counties, Oregon, may be an undescribed species or a variety with somewhat distinct morphology.

References: Caldwell (89); Sprague (655).

RHYNCHOSPORIUM SECALIS (Oud.) J. J. Davis, Scald.

The lesions are at first dark bluish-gray, water-soaked in appearance, later the collapsed tissue becomes light gray with a dark brown margin, sometimes irregularly zonate, often completely killing "scalded" leaves.

This fungus causes a serious disease of barley in Oregon, Washington, and California. Losses in winter barley in western Oregon and California often average 10 percent and losses up to 30 percent of the crop are reported. Even when all the leaves on some varieties have been 100 percent scalded the plants recover and give fair yields. This has erroneously led observers to believe that the temporary loss of foliage is unimportant. Wiebe, Caldwell (89, p. 176), and others have found this to be untrue. This disease is gradually becoming recognized as worthy of major consideration.

Besides barley, R. secalis occurs more or less spasmodically on a number of grasses and cereals in Oregon and Washington and scatteringly eastward as follows:

Oregon: Agropyron dasystachyum (Hook.) Scribn., A. repens, Agrostis

alba, Elymus glaucus, Hordeum jubatum, H. murinum, Lolium multiflorum, L. perenne, Secale cereale.

Washington: Agropyron repens, A. semicostatum, A. trachycaulum, Bromus carinatus, B. inermis, Elymus canadensis, E. condensatus, E. glaucus, E. junceus, E. triticoides, Secale cereale.

Idaho: Agropyron subsecundum.

California: Agropyron repens, Secale cereale.

Minnesota: A. repens.

South Dakota: Phalaris arundinacea.

Wyoming: P. arundinacea.

North Dakota: A. repens, P. arundinacea.

The collections on Phalaris arundinacea are less strongly beaked than most of the other collections (see B.P.I. 80,456). The spores are 13-18 x 2.3-2.8 µ.

In his detailed study, Caldwell (89) recognized six highly specialized physiologic races, which were distinguished by their ability to attack one of six hosts: rye, barley, quack grass, smooth brome, Canada wild-rye, or Hordeum jubatum. None of these, except the race from Canada wild-rye, could attack a host species of a genus other than that from which it was isolated. The race from Canada wild-rye could attack Agropyron trachycaulum, which is more or less to be expected as fungi attacking Agropyron trachycaulum or other members of the genus would likely also attack some members of the related genus Elymus. No doubt, were all of the additional hosts tested for racial affinities, several unrecognized strains would now be found.

References: Bartels (23); Caldwell (89); Davis (141, p. 713); A. G. Johnson and Mackie (371); Mackie (425).

SCOLECOTRICHUM GRAMINIS Fckl., Leaf Streak.

The shape, color, and extent, of the lesions caused by this fungus vary with age and host species. In its most common condition it occurs as elongate gray, brown-ochraceous to stramineous streaks on the leaves with aniline to sulphine yellow borders in which the black clusters of conidiophores appear as minute dots in seried arrangement. Younger stages show water-soaked circular to elliptical lesions which are deep olive gray in the morning when dew-wet, and deep dull gray when dry. These spots become brown, purple-brown to ocher with gray centers, with

a tendency to form streaks gradually as the leaves die.

This fungus is readily distinguished by the prominent black densely fascicled conidiophores arranged in parallel rows as black dots along the surface. Without a hand lens, they are sometimes mistaken for pycnidia. Less frequently they may be plentiful enough to give a sooty mold aspect to the underside of the leaves. The spores are Indian-club shaped, i.e., fusoid-obclavate, 35-45 x 8-10 µ, 1- or sometimes 2-septate, olive brown.

The correct name of this fungus has never been settled to the satisfaction of all workers, although most of them use the old name, S. graminis, which Fuckel proposed in 1863 (241, No. 134). Horsfall (340) suggested that all available evidence indicated that Cercospora graminis (Fckl.) Horsfall would be a satisfactory name for the fungus. He stated that Von Höhnel (Centrbl. Bak. 2:60: 1-26. 1924) considered Scolecotrichum as probably invalid. Until the matter is settled, the writer uses the name that is recognized by most workers. Synonyms for the fungus include: S. compressum Allesch. (Hedw. 35(2): 34. 1896); Cercospora graminicola Tracy and Earle (Torr. Bot. Club 22: 179. 1895); Passalora graminis (Fckl.) Hoehn. (Centrbl. Bakt. 2:60: 1-26. 1924); Passalora dactylina Pass. (In Lindau, G. Rab. Krypt. Fl.1:8: 793-799. 1907); S. graminis var. nanum Sacc. (In Höhnel, F. von. Centrbl. Bakt. 2 etc. 1924); Napicladium gramineum Pk. (Sprague, 657) and probably Cercospora poae Baudyš and Picb. 25);(Chupp, in letter to Sprague, 657).

Scolecotrichum graminis is known to occur on at least 104 species of Gramineae in the United States, 94 of them being included in this report. Of these, 10 are species of Agropyron; 6, of Agrostis; 4, of Alopecurus; 8, of Bromus; 9, of Elymus; and 13, of Poa; as well as 44 species of 22 other genera. The host range on Gramineae is almost unlimited. Horsfall listed only 28 host species in 1930; Seymour, about 27 for the entire United States. Still further study will no doubt add many more to the host range of this omnipresent species. S. graminis is particularly common on the Pacific Coast, but is abundant in the Plains country as well. It ranks as one of our most important leaf spot diseases of timothy, orchard grass, blue grass, tall meadow oats grass, and red top. Sometimes it is less serious than it appears to be because the fungus sporulates profusely in late season and develops saprophytically on many hosts on which it is only mildly parasitic. It is frequently secondary to other fungi. It is not important on cereals but sometimes occurs on rye in the coast region of Oregon. Once it was found on 40 percent of the leaves of rye in early May near Alsea, Oregon, (Sprague, 641) and on another occasion it was found on rye heads in the same general area. Guarch (301) reported S. graminis var. brachypoda Speg. on rye in Uruguay, and Jankowska (361) lists it from Poland on rye, and also as causing slight injury to wheat. Shitakova-Roussakova (605) reports the disease as widely distributed and of moderate importance on rye in the Soviet Union. She found some varietal resistance. Landaluze (397) reports S. graminis as a secondary parasite of rye in a

hilly region in Spain where the soil was pH 5.4. This condition is similar to that encountered near Alsea, Oregon, where the soil is highly acid (pH 4.9-5.5) and very deficient in nitrogen and phosphorus. Probably the injury on rye is not representative of strong parasitism in many cases.

Tabulation of about 250 collections of S. graminis shows that this fungus may be found any month of the year, but in Oregon its greatest activity is from March to July with a secondary development in the fall after the rains start again. Injury is greatest on older plants in spring. In the Great Plains, the fungus develops in May and June, but profusely fruiting material has been collected from May until late September.

This fungus needs critical study to determine its physiological status. Morphological variants occur (as on Poa ampla Merr. in Klickitat County, Washington), but whether they are anything more than variations due to host and humidity is not known.

Information on the control of this disease is scanty. Certainly grass weeds such as Hordeum jubatum and Beckmannia syzigachne probably aid in spreading it. Burning over fields no doubt reduces the injury from this fungus, which is able to increase its inoculum through saprophytic or semi-saprophytic development while the host is dormant or necrotic in very early or late season.

References: Fischer, et al. (231); Fuckel (241); Guarch (301); Horsfall (340); Jankowska (361); A. G. Johnson and Hungerford (370); Krause (390); Landaluze (397); Nilsson-Ehle (484); Shitakova-Roussakova (605); Sprague (641, 657); Trelease (709).

SCOLECOTRICHUM MACULICOLUM Ell. and Kell., Leaf Spot.

Prominent, elliptical, dirty-white spots form on the broad, living leaves of Phragmites communis. Originally described from Kansas (Ellis and Kellerman, 217), this fungus has been collected several times in one locality on Young's Bay, near Astoria, Oregon. The fungus has not been studied critically nor compared closely with S. graminis. It has spores 20-22 x 8-11 µ borne on conidiophores 40 x 4-5 µ. S. graminis has spores 35-45 x 8-10 µ (Saccardo 558 v. 4: 348) borne on conidiophores, 90-100 x 6-8 µ.

SPOROTRICHUM SP.

This fungus causes an obscure leaf killing on Agropyron spicatum, A. inerme, and A. subsecundum in Washington, Idaho, and Montana. The stromata are barely visible to the naked eye as fine, white stippling on dried leaf parts. Spores, which are intimately associated with the

branched septate hyphae, are 3-8 x 2.5-6 µ and secondary spores are produced by budding.

References: Sprague (668, 669).

STEMPHYLIUM SPP. (See Alternaria.)

Stemphylium botryosum Wallr. (Ascigerous stage, Pleospora herbarum (Pers.) Rab.) is the most abundant species, but it is of slight importance.

References: (Wiltshire, 768); (Groves and Skolko, 293).

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PLANT DISEASE REPORTER SUPPLEMENT

Issued by

THE PLANT DISEASE SURVEY
DIVISION OF MYCOLOGY AND DISEASE SURVEY

Plant Industry Station Beltsville, Maryland

LATE BLIGHT ON POTATO AND TOMATO IN 1946

Plant Disease Reporter
Supplement 164 July 15, 1946

FOREWORD

Reports that late blight (Phytophthora infestans) was appearing to an alarming extent were received from several commercial tomato-growing areas. With the aim of presenting a systematic and timely account of the development of the disease this year on its two important hosts, the Survey asked its collaborators in States where late blight is likely to occur to send reports of its incidence on either or both potato and tomato, especially as to the following points:

1. Has the disease occurred on either host and to what extent?
2. What control measures, if any, have been taken?
3. When was the disease first noted, and what in your opinion was the original source of infection?

The answers to this request, except for a few negative replies, are given below. Together with reports from various Florida sections that have appeared in each number of the Reporter, from December of last year to the current issue, they give a rather complete story of the occurrence of the disease to about the middle of June this year.

Some of the factors brought out in the reports may be briefly indicated:

Weather has been unusually favorable for late blight development over a long period of time and over a widespread area. (See Figure 1, 2, 3, 4, and 5.)

The disease is reported as appearing much earlier in several States this year than previously.

The reports from State pathologists and collaborators as to original source of infection raise an interesting question of reciprocal responsibility. Northern-grown potato seed is implicated as a source of infection for potatoes in southern areas and for potato and tomato in some Middle Atlantic States. Infection of tomato in some southern States is believed to have resulted from windblown inoculum, and in one case from infected plants, from even farther South. In most, though not all, northern tomato areas the source is given as southern-grown plants; in some cases these are believed to be the source of inoculum for both tomato and potato. In one State, however, plants were not known to have been brought from an outside source until after the disease had already been noted.

Figures 1 to 5. Summary representations of weather, February to June 1946. Figure 1, February; Figure 2, March; Figure 3, April; Figure 4, May; Figure 5, June. Maps are combinations of the maps showing departure from normal temperature and percentage of normal precipitation, from the Weather Bureau Weekly Weather and Crop Bulletin.

Unshaded: Temperature and precipitation both below normal (Cd)

Temperature above, precipitation below normal (Wd)

Temperature below, precipitation above normal (Cw)

Temperature and precipitation both above normal (Ww)

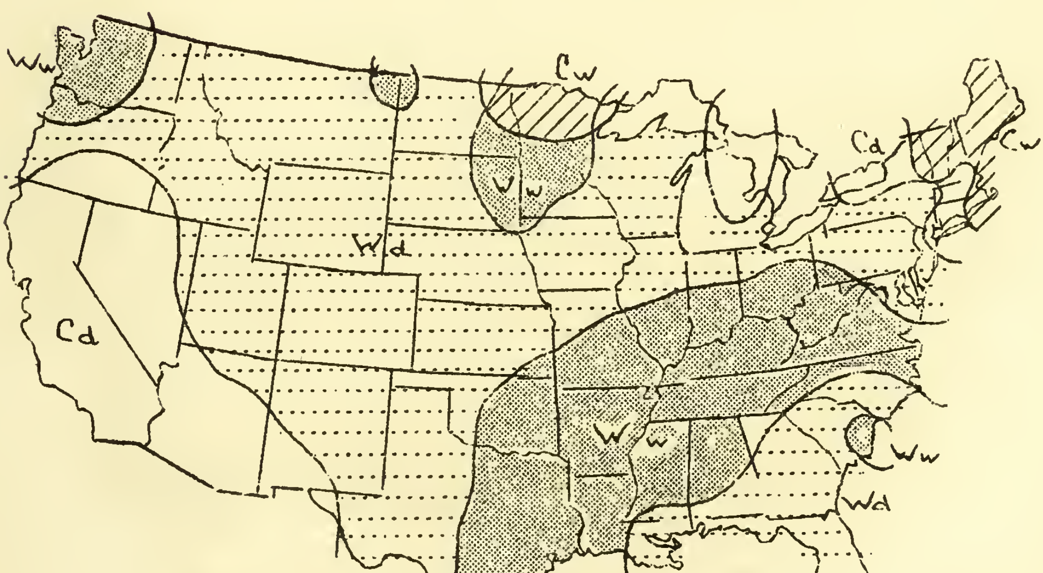

Figure 1. Weather of February, 1946. For explanation see above.

Figure 2. Weather of March, 1946. For explanation see page 271.

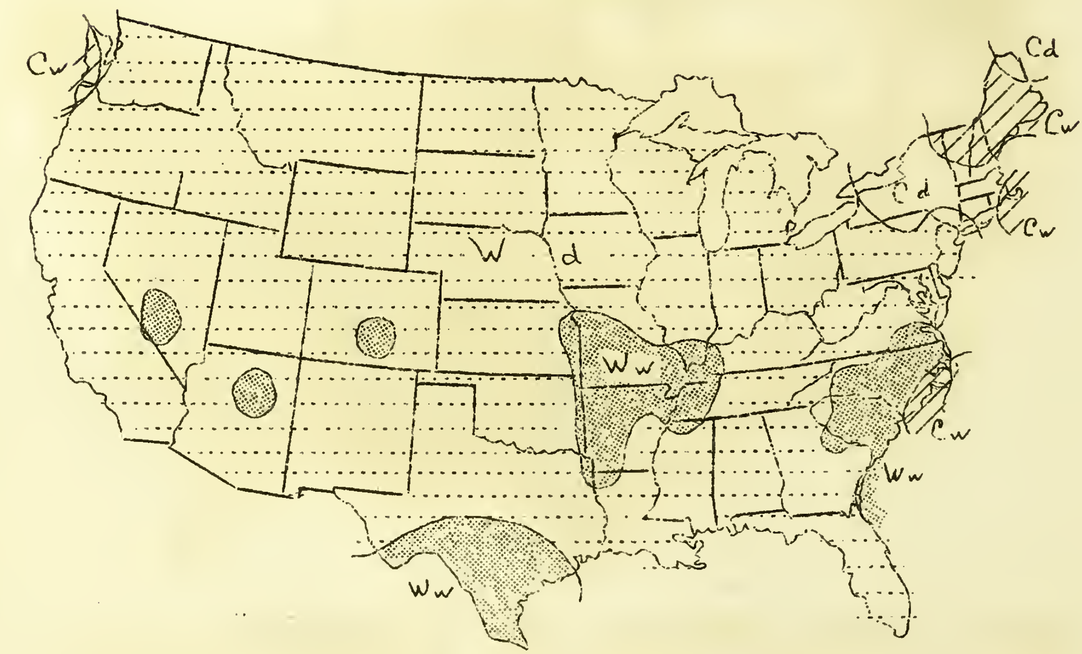

Figure 3. Weather of April, 1946. For explanation see page 271.

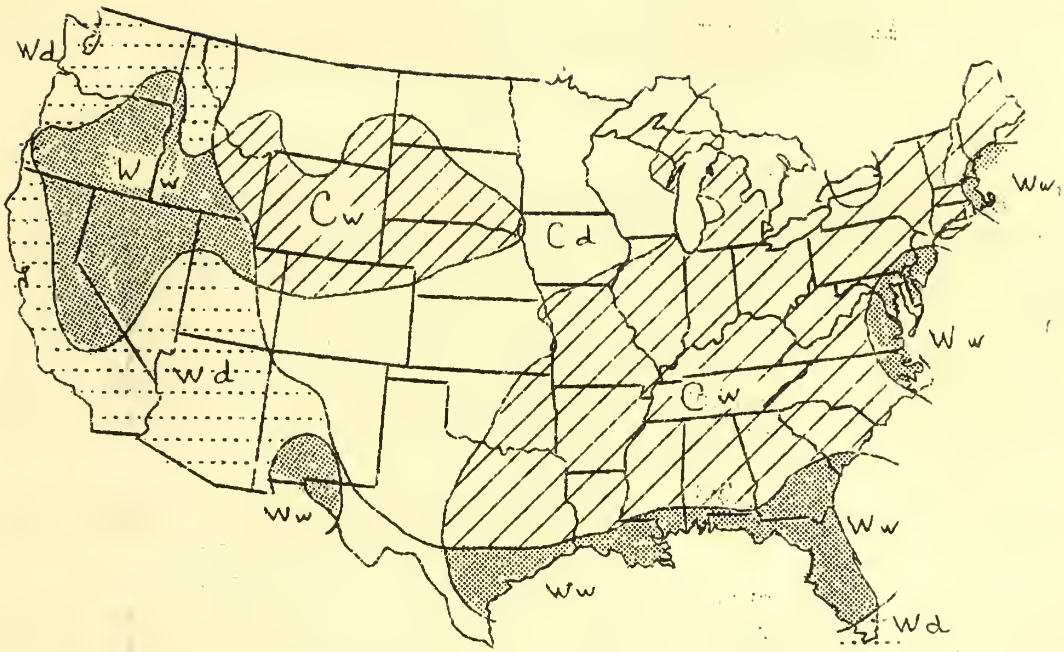

Figure 4. Weather of May, 1946. For explanation see page 271.

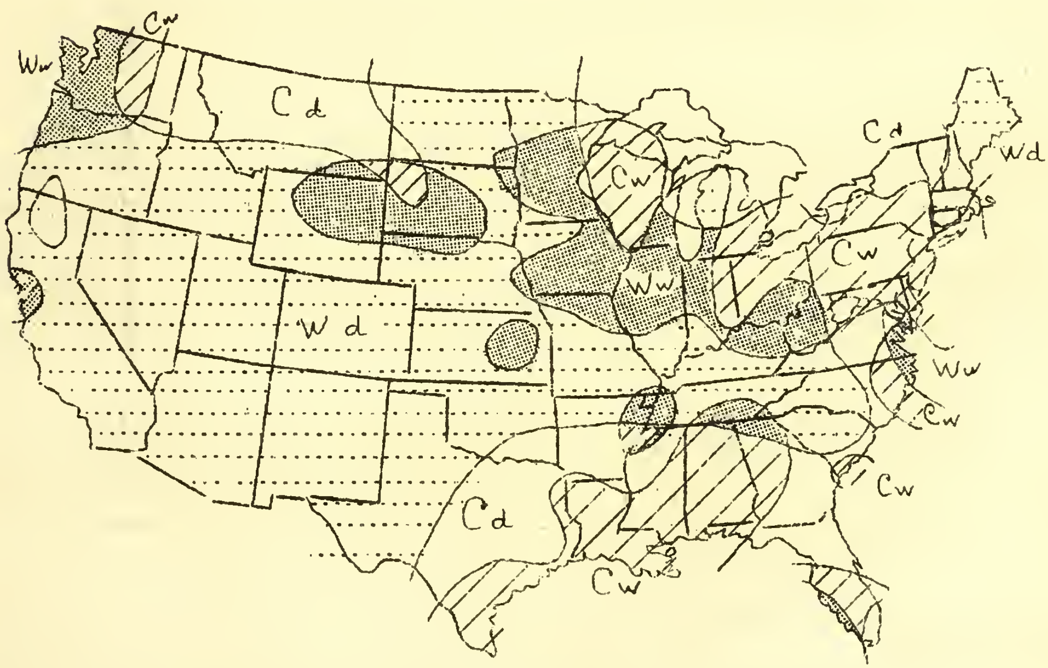

Figure 5. Weather of June, 1946. For explanation see page 271.

LATE BLIGHT ON POTATO AND TOMATO IN LOUISIANA

L. H. Person

Late blight was first observed on potatoes on April 9, 1946, in La Fourche Parish. It was later observed in Terrebonne and Pointe Coupee Parishes. Infection was rather general by the end of the season, but not so severe as in 1944. Little damage occurred on early planted potatoes, but on later potatoes some damage was evident which is difficult to estimate since a continuous 10-day rainy spell occurred at the time the potatoes should have been harvested. Considerable loss occurred from the combination of late blight and unfavorable wet weather conditions on the late planted crop.

Some spraying with Dithane and some dusting was done to control the disease.

The initial infection when first noted was in localized spots in the fields, which indicates seed-borne infection. No field was observed early in the season, April 9 to 15, in which general infection was noted.

Through our seed inspection service, eleven carloads of seed were rejected on account of the presence of late blight in the seed potatoes.

Late blight has been noted on tomatoes following the 10-day rainy spell during the latter part of May and early June. Both fruits and leaves have been infected, with heavy sporulation on the leaves. Fruits placed in moist chambers have produced spores similar to those of _Phytophthora infestans_. The blight that occurred on tomatoes was definitely not _P. capsici_. A few volunteer potato plants in one garden patch were lightly infected with _P. infestans_, while the tomato leaves were heavily infected.

Our commercial tomato region is very small and whether the late blight occurred there I do not know, as I have not seen this area. The disease on tomatoes has been noted in several gardens and in test fields on the experimental plots at Baton Rouge. No control measures have been carried out on tomatoes.

LOUISIANA STATE UNIVERSITY
June 20, 1946

LATE BLIGHT ON POTATO IN MISSISSIPPI

John T. Presley

Late blight occurs on potatoes and tomatoes early in the season in Mississippi. So far as our observations go, late blight caused some damage to garden plots of potatoes in the southern part of the State during May.

We have not noted any outbreaks of late blight on tomatoes.

So far as I know, very little control measures are being practiced either on potatoes or tomatoes in this State. It is quite possible that the original source of infection was farther south, perhaps in Louisiana or Texas, and wind borne inoculum could have traveled as far north as southern Mississippi by the time the disease was noted in that area.

MISSISSIPPI AGRICULTURAL EXPERIMENT STATION
June 21, 1946

LATE BLIGHT ON POTATOES AND TOMATOES IN ALABAMA IN 1946

Coyt Wilson

The first report of late blight in Alabama in 1946 was on March 25, when blighted potatoes were found in the southern part of Baldwin County, approximately 40 miles southeast of Mobile. The disease spread slowly and did not reach epidemic proportions until the last two weeks of May.

By this time most of the potatoes had been harvested, but the commercial plantings of early tomatoes were just reaching maturity. John Bagby, Extension Specialist in Fruit and Vegetable Marketing, estimates that 75 percent of the tomatoes in Houston County (extreme southeastern corner of Alabama) was destroyed by late blight. Tomatoes in home gardens as well as commercial plantings were heavily damaged throughout the southern half of Alabama.

Weather played an important part in the epidemic that swept through the State. While the April and May rainfall records given in the table below are for Auburn, they are representive for the southern half of the State. The total precipitation for April was 1.88 inches below normal, and there was no rain the first 10 days of the month. Undoubtedly this was largely responsible for the slow spread of the disease after its first appearance in late March.

In May, however, total precipitation was almost double normal rainfall. During the latter part of April Phytophthora infestans was disseminated over large areas of Alabama, and scattered infections could be found in most potato fields by the time they were harvested early in May. Thus, the inoculum from the potatoes reached the tomatoes and May provided the necessary environmental conditions for an epidemic.

Most Alabama potato growers, realizing the danger of late blight from previous experiences, started dusting or spraying during the latter part of March. Very few people were equipped to spray properly, and most of the growers followed a dusting program using one of the copper dusts. Almost all of those who sprayed used Dithane. Some dusting was done by airplanes.

It was not possible to evaluate the efficiency of the different methods. All of them appeared to be effective under the conditions that prevailed this year. Quite a few growers hold the opinion that the widespread use of dusts or sprays helped to prevent an epidemic on potatoes. This may have been true in the southern part of Baldwin County, since those fields on which no control measures were practiced suffered considerable damage from late blight. But farther north where lower humidities prevail the dry weather probably should be given more credit for the control than the dusting or spraying.

Rainfall at Auburn, Alabama, during April and May, 1946

Date	Precipitation (Inches)	Date	Precipitation (Inches)
April 11	0.18	May 2	0.28
April 12	0.27	May 7	0.02
April 16	1.07	May 8	0.17
April 18	0.01	May 12	0.96
April 24	0.76	May 14	0.57
April 25	0.30	May 15	1.93
Total	2.59	May 16	0.28
Deviation -1.88		May 17	0.06
		May 18	0.59
		May 20	3.38
		May 21	0.02
		May 25	0.20
		Total	8.46
		Deviation +4.12	

Tomato growers of south Alabama were caught unprepared. A few of the growers were attempting to spray with Bordeaux, using small compressed-air sprayers. After the epidemic was well underway in southern Alabama, most people attempted to start a dusting program using a dust containing 5 percent metallic copper. Small hand or knapsack dusters were used and only fair success was obtained. The first picking was lost in practically all fields and in many instances the entire crop was lost.

The commercial tomatoes of north Alabama are set in the field about the time those in south Alabama are harvested. However, early plantings are made for home use. Late blight is already present in at least half of the gardens of north Alabama. There is every reason to expect an epidemic of late blight on these late tomatoes if the weather is favorable for its development and spread. Growers have been warned and the majority of them are making preparations to dust. However, they have no power dusters and unless the weather cooperates, they are likely to be only partially successful.

Lack of suitable power spraying or dusting machines is a serious handicap to the development of a satisfactory spraying or dusting program for tomatoes in Alabama. Most of the tomatoes are tied to stakes to keep the fruit and vines off the ground. The height of the stakes makes the use of power-driven machinery impractical. If late blight should continue to be a serious problem, the method of planting and handling will have to be changed or portable power units will have to be designed.

All available evidence indicates that the original source of infection was diseased potato seed. All of the first infections were found in fields planted with seed known to contain blight. It appears, though, that wind was responsible for dispersing the inoculum from these infection centers to adjacent fields. The maximum distance over which viable inoculum was moved by wind is not known, but infections have been found in tomato fields located a full mile from any potatoes.

ALABAMA AGRICULTURAL EXPERIMENT STATION

LATE BLIGHT ON TOMATO AND POTATO IN TENNESSEE

J. O. Andes

Late blight on tomatoes was widespread and the damage severe. Inasmuch as there is no way of determining what the losses are in gardens, no estimate is made. On the field crop in West Tennessee reports are from total loss to slight damage. Control measures are nil because spraying for tomatoes has not been demonstrated conclusively as prof-

itable here. Late blight is sporadic and any control measures must be designed to take care of the major problems aside from this one and at the same time give protection if blight should strike. Under the present situation I think the growers will be receptive to a control program, and I am now in a position to try it out.

The disease was noted quite early in the season when the plants were just being set out. My guess as to the original source of infection is that the fungus is indigenous, because it spread over a wide area and on several solanaceous plants.

Late blight on potatoes coupled with black leg was disastrous this year. The few people that used a thorough spray program have had no trouble, although adjacent fields were ruined.

UNIVERSITY OF TENNESSEE
June 20, 1946

SUMMARY OF LATE BLIGHT ON TOMATOES IN GEORGIA

Julian H. Miller

Following a survey in the middle of May [in P.D.R. 30, no. 7, July 15], in Tatnall County, the center of the green pack area in south Georgia, the writer made a second inspection June 4-5. In the interim the weather had changed to dry and hot long enough to check the late blight somewhat. About 15 fields planted in home-grown plants, and only slightly infected in May, were now producing some tomatoes free of spots, but nearly all of the early plantings from Florida plants were lost. Loss of crop was estimated at 75 percent by the county agents, market master, and others. This was not only in fruit loss. The average price last year was above $3.00 per bushel, while the few tomatoes that were sold this year brought between $.75 and $1.50 after the second day of the market openings.

Only a few farmers attempted sprays. Spraying of tomatoes has never been practiced here, and there was almost no spray machinery or materials to be had. Four farmers had sprayed with Bordeaux, one four times and the rest one spray each. The results were not satisfactory. In the first field there were apparently fewer fruit infections, but the leaves looked about the same as in unsprayed fields.

On this trip the writer examined the remnants of fields of young plants for the northern shipping trade, and they were also heavily infected with this blight. It will be interesting to see how much of this has been carried over into northern canner fields in New Jersey, Indiana, etc.

There are no large commercial potato plantings in this Tatnall area, but all small home patches examined on this trip were infected.

UNIVERSITY OF GEORGIA
June 20, 1946

LATE BLIGHT ON POTATO AND TOMATO IN GEORGIA

B. B. Higgins

We have not been able to make a systematic survey to determine the loss from late blight damage to the potato and tomato crops in Georgia. During the past two months numerous letters and inquiries in regard to the disease have been received. The first inquiries were received from residents of the southeast Georgia Coastal Plain, and practically all indicated serious damage to both potato and tomato.

On the morning of May 25, following several days of heavy rains and cloudy, cool weather, I noticed late blight in my own garden in Griffin. The disease was already prevalent and the conidia and conidiophores so abundant as to be conspicuous on the foliage even at some distance. At the same time a few spots were found on tomatoes. Both were dusted with a copper dust that afternoon and the dusting repeated a week later. This, with a period of hot sunny days beginning the second week of June, has halted development of the disease on the tomatoes, but the potato foliage was almost completely dead within a week after the disease was first noticed. Damage amounted to about 50 percent of the crop.

This is the first time I have seen this disease in the Piedmont section of Georgia during the 32 years I have been at this Station. Undoubtedly the continuous cool weather with frequent rains and cloudy days, continuing into June, is responsible for the unusual spread of the disease (from Florida potato section ?).

In the coastal plain region of the State a considerable acreage of tomatoes is planted for early market. Reports indicate heavy losses in these fields. Experiment Station men on a tour of that region last week reported that every field of tomatoes seen appeared to be almost completely defoliated by the disease. A newspaper report stated that 75 percent of the crop was lost.

The commercial early potato crop in Georgia is small and localized near the coast and I have no information as to damage to this crop.

GEORGIA AGRICULTURAL EXPERIMENT STATION
June 25, 1946

TOMATO AND POTATO LATE BLIGHT IN SOUTH CAROLINA, 1946

William M. Epps

Tomato late blight, caused by the fungus Phytophthora infestans (Mont.) De By., has been very serious in all of South Carolina's commercial tomato-producing areas in 1946.

In general, the potato crop was not injured by late blight. A few isolated lesions were found in a field of Katahdin potatoes on Edisto Island in Charleston County on April 29. Subsequent spread of the disease was slow, but by the middle of May some blight was present in most of the potato fields in Charleston County. Since the crop was being harvested at the time blight appeared, little or no reduction in potato yields resulted. Late blight tuber rot was observed only on an occasional tuber. Damage from this source was negligible; however, inspection reports from terminal markets revealed the presence of late blight rot in a few cars of Charleston County potatoes.

Late blight was discovered in the tomato breeding plots at the Truck Experiment Station at Charleston May 18, four days after it was first observed in an adjacent potato field. Within the following ten days, specimens were received from Charleston, Beaufort, Colleton, and Orangeburg Counties. In these areas the epiphytotic reached its peak about June 4. About June 1 the disease appeared abundantly in Dillon County. A survey in Dillon County tomato fields on May 25 had revealed only a few widely separated single lesions. Soon after June 4 the occurrence of hot dry weather checked the spread of the disease almost completely in all affected areas.

Destruction of the crop was almost complete on many farms, particularly in Orangeburg and Beaufort Counties. In the test plots at the Truck Experiment Station about 85 percent of the early fruits were infected with late blight rot and discarded at picking or rotted after picking and before they could ripen. The later maturing fruits were not so seriously damaged by fruit rot, but were severely scalded by the sun after the plants were defoliated by late blight. It was estimated that the damage to the Experiment Station variety trials was in excess of 90 percent. In Dillon County the tomato market opened and then closed, since much of the early fruit sold showed late blight lesions upon arrival at its destination. It reopened after the disease was checked by the change in the weather. At least one large tomato farm in Charleston County escaped the blight entirely even through no fungicides were used.

A fixed copper dust with 6 percent metallic copper was recommended for control of the disease. In many instances, however, the pathogen had gained such a foothold that dusting was not recommended. Where the

dust was properly applied before the disease had become too serious, it was effective and satisfactory control was obtained.

It was apparent from the spread of the disease across the State from south to north that the sporangia were spread progressively by wind. It appears extremely unlikely that the disease was introduced on plants shipped into the area from other areas farther south. The appearance of blight in tomatoes closely followed its appearance in potatoes in the coastal counties of Charleston and Beaufort. No central foci of infection were found unless the infected field of potatoes on Edisto Island could be termed such a focus. This field probably represented only one stride in the spread of the pathogen across the State from south to north.

SOUTH CAROLINA TRUCK EXPERIMENT STATION
CHARLESTON, June 28, 1946

LATE BLIGHT ON POTATOES AND TOMATOES IN NORTH CAROLINA

WESTERN NORTH CAROLINA

By H. R. Garriss

Late blight is present on both potatoes and tomatoes in Henderson, Jackson, Macon and Clay Counties. The disease has already caused extensive defoliation of potatoes, especially those of the Cobbler variety. Late blight is general on tomatoes (mostly home garden plantings) but where it is present is causing extensive defoliation. In Mitchell County as of June 15 late blight was less widespread than in the areas south. Fixed copper dusts are being widely used on tomatoes.

Late blight is off to an earlier start this year than in 1945 when it almost completely destroyed the tomato crop of the entire area and caused heavy damage to potatoes.

TOMATOES -- EASTERN NORTH CAROLINA

By D. E. Ellis

On the basis of field observations and inquiries from county agents and growers it is evident that tomato late blight has occurred in widely scattered areas over most of the eastern part of North Carolina in both the Piedmont and the Coastal Plain. Severe damage seems to be limited, however, to a relatively small acreage of commercial plantings in Scotland and Sampson Counties. The epiphytotic was of

comparatively short duration and there has been practically no development and spread of the disease since about June 6 when warm weather set in. The appearance of late blight on tomatoes in Eastern North Carolina is very unusual.

POTATOES -- EASTERN NORTH CAROLINA

By J. H. Jensen

Late blight was present in epiphytotic form in Eastern North Carolina in 1945 but came too late to cause more than slight damage. In 1946 first evidences of the disease were noticed the second week in May. Continued cool weather and frequent rains permitted the build up of widespread infection throughout almost all of the commercial potato area by the first of June. Extensive acreages of potatoes were defoliated a week or 10 days before the usual digging date and considerable reduction of yield in some fields resulted. With the exception of a few growers no spraying or dusting control measures for this disease were practiced. Airplane dusting with copper dust in one area is reported to have been helpful and to have prevented excessive defoliation. Spraying with Bordeaux mixture and with Dithane has given some control for a few growers.

NORTH CAROLINA STATE COLLEGE

LATE BLIGHT ON POTATOES AND TOMATOES IN EASTERN VIRGINIA

Harold T. Cook

Potato vines badly affected with late blight were received from Northhampton County on the Eastern Shore on May 23. A survey on the Eastern Shore on May 24 showed that blight was generally present in small amounts in both Accomac and Northhampton Counties and that it was already causing considerable damage in spots in a few fields.

A badly blighted section of one farm was found in Princess Anne County on May 27, but only a trace of blight has been found in the rest of that county.

Blight was generally present in potato plantings in Nansemond and Norfolk Counties on May 28. It has continued to spread and do considerable damage in those counties. In one field in Norfolk County that appeared to be free of blight on May 22, the vines were entirely dead in some spots and other vines had lost at least half of their foliage one week later.

A survey of the tomato plantings on the Eastern Shore on June 11 showed that blight was present in nearly all fields, but that it had caused serious damage only in those adjacent to badly blighted potato plantings.

This is the first bad outbreak of late blight on potatoes of the early crop since 1938 and the first time that more than a trace has occurred on tomatoes.

The weather this season has been especially favorable for the development and spread of late blight. Rainfall since the middle of May has been considerably above normal and temperatures have been generally below normal.

Spraying with 4-4-50 Bordeaux mixture or dusting with 20-80 copper-lime dust was recommended for the control of blight on potatoes. Spraying or dusting with the same materials has been suggested for tomatoes, but has not been strongly advocated since the disease is expected to disappear when normal temperature and rainfall become prevalent.

The source of infection in the potato crop is probably diseased seed potatoes. Blighted potato fields appear to be the source of inoculum for tomatoes.

VIRGINIA TRUCK EXPERIMENT STATION
June 18, 1946

LATE BLIGHT ON POTATO IN WESTERN VIRGINIA

S. B. Fenne

Late blight first appeared on potatoes in the vicinity of Blacksburg on May 27. Since that time, a few additional cases have been recorded but no epiphytotic has developed here. Some home gardeners are dusting their potatoes with copper and DDT. I have not yet seen late blight on tomatoes nor had any reports of it.

VIRGINIA POLYTECHNIC INSTITUTE
June 17, 1946

LATE BLIGHT OF POTATOES AND TOMATOES ON THE EASTERN SHORE OF MARYLAND

C. E. Cox, R. A. Jehle, and M. W. Woods

On July 10 and 11 a survey was made of the late blight situation on potatoes and tomatoes in the three lower counties (Wicomico, Somerset and Worcester) of the Eastern Shore of Maryland.

For the most part potatoes were in blossom while tomato plants varied in size from field to field. In the later planted fields tomatoes were about a foot high and just beginning to bloom while in earlier plantings there were green fruits up to an inch and a half in diameter. In general the crown set of fruit was poor.

At least a trace of late blight (Phytophthora infestans) was found in practically every potato and tomato field visited. Up to 30 percent of the foliage was infected, with almost 100 percent of the plants showing some lesions in the most severely affected potato field inspected. The most severely affected tomato field showed up to 10 percent of the leaves involved with the majority of the plants showing some lesions. No lesions were observed on the green tomato fruits.

Late blight on potatoes was first observed by Dr. R. A. Jehle on June 4 near Pocomoke City in Worcester County. It is unusual for this disease to appear so early in the season. During the past 20 years, Dr. Jehle has observed it only once before in such proportions on the early potato crop. Late blight on tomates was first observed this year by Dr. W. F. Jeffers and County Agent J. P. Brown on June 6, in a planting near Salisbury in Wicomico County. Such an outbreak of late blight on tomatoes has never been observed before on the Eastern Shore of Maryland.

It is estimated that the potatoes have been infected for several weeks, possible as long as a month. Potatoes from home-grown seed were less severely affected than those from northern-grown seed even when planted together in the same field.

Every severely affected tomato field observed was located adjacent to a potato field. Tomatoes isolated from potato fields showed only traces of late blight. This would indicate that potatoes have served as the original source of infection. There was no indication that tomato plants were infected when they were planted.

Potato growers, for the most part, are equipped to spray or dust. It is customary for them to apply insecticides only on the early potato crop. Many of them will spray with Bordeaux Mixture-DDT dust or with copper-DDT dusts. Tomato growers do not spray or dust their crop

as a general practice and some do not own proper sprayers or dusters. Some of them will attempt to control late blight if it continues to spread with Dithane-zinc-lime sprays or with fixed copper sprays or dusts.

Losses on the potato crop are not expected to be great if growers delay harvest until the tops are dead and dry. Losses of tomatoes as a result of the late blight will depend upon weather conditions. If it becomes hot and relatively dry, it seems unlikely that late blight will spread. If it remains wet and cool, losses from defoliation and fruit rot will probably be severe.

UNIVERSITY OF MARYLAND
June 18, 1946

LATE BLIGHT IN DELAWARE

J. W. Heuberger

June 26: Late blight was found on one tomato plant in a victory garden on May 29. On June 5, 3 plants to one side of the original plant and 2 plants to the other side were found infected.

No late blight was found on a row of potatoes 6 feet away and paralleling the row of tomatoes. This row of Cobbler potatoes was planted exactly in the area occupied by a row of Dakota Red potatoes last fall. The Dakota Red potatoes last fall were killed early by late blight and the tubers were left in the ground over the winter. No late blight was found in the Cobbler potatoes in that area this spring until June 14. Late blight is now developing on the potatoes but has ceased development on the adjacent row of tomatoes.

The row of tomatoes contained southern grown plants and on checking other fields planted from the same shipment of southern plants I found one field that had 3 infected plants.

On further checking, I found that the field that had late blight and the row of tomatoes in the victory garden that had late blight were planted with plants from the same basket. Thus, the late blight must have come in on a few infected southern grown plants.

I have only found late blight on potatoes in one other location in the State, at Angola which is about 5 miles back from the ocean front. A 5-acre field was completely destroyed in this area. Adjacent fields show no infection.

During the past four weeks I have been in more than 50 tomato fields

and 30 potato fields, all over the State of Delaware, and have failed to find late blight except where indicated above.

The weather in Delaware is now quite hot and dry and we are anticipating no further trouble from late blight on tomatoes and potates.

On tomatoes, I am positive that the two cases can be traced to infection on southern grown plants. On potatoes, I feel certain that the infection can be traced to infected tubers.

July 6: Commencing Friday, June 28, we had torrential rains extending through July 2. In fact, on July 2 we had 4.35 inches of rain in the lower end of the State. The weather stayed cool during the rainy period and it is still cool. During the week of July 1, I resurveyed our tomato fields and found that late blight was present throughout the State. Infection has been found at as widely separated points as Newark, Delmar, and Selbyville. Most of the infection is primary, with some secondary infection. In the Selbyville area, however, secondary infection is so serious that little hope is held for saving the plants.

As the long-range weather forecast for July is considerable rainfall, subnormal temperatures, and subnormal sunshine, it is anticipated that late blight of tomatoes will be destructive in Delaware. We are recommending the use of Dithane plus zinc sulfate plus lime as first choice for control of this disease. Our second choice is fixed copper sprays or dusts. All of the infection in Delaware is leaf infection as our fruit has not yet sized up.

UNIVERSITY OF DELAWARE

LATE BLIGHT ON POTATO IN NEW JERSEY

C. M. Haenseler

Phytophthora (late blight) has been observed in several fields. One report from our Burlington County Agent states that the disease was very prevalent in one field in his county. Specimens sent in by him were confirmed as *Phytophthora* in our laboratory.

I inspected one field in Burlington County on June 17 and observed a trace of *Phytophthora* on the old leaves. The diagnosis was confirmed by laboratory examination.

A Middlesex County field in which late blight had caused almost total loss of crop in 1945 was carefully examined on June 14, 1946 and

no trace of the disease was found.

It may be concluded therefore that late blight is present on potatoes in New Jersey, but that at present the disease is of very little importance and apparently absent except in a very few exceptional fields.

I have examined several tomato fields for late blight and have failed to find it so far. We likewise have had no report of the disease from County Agent or other sources. Reports from representatives of a canning company state that the disease has been observed on tomatoes outside of New Jersey but that they had no reports as yet of its occurrence on any of this New Jersey acreage.

The potatoes are sprayed or dusted regularly with fungicide-insecticide mixtures but no specific measures have been taken against the late blight as such.

Our first report of late blight on potatoes in 1946 was June 7 from Burlington County.

The original source has not been proved but since the disease is not present in many fields where the crop was severely diseased last year diseased debris from the previous years crop does not appear to be the most probable source of inoculum.

Since these reports were made an additional report has been received of a field of potatoes in Burlington County severely infected with late blight.

NEW JERSERY AGRICULTURAL EXPERIMENT STATION
June 20, 1946

LATE BLIGHT ON POTATO AND TOMATO IN NEW YORK

Charles Chupp

Late blight occurred early on both the north and south fork of Long Island. It was present before the middle of June. An interesting thing about its occurrence happened this season. In the past, the growers did not treat potato seed before planting. Consequently, any culls or tubers that were thrown out were fed to livestock. This year, after Dr. Cunningham had found that seed treatment reduced seed-piece decay, nearly all the potatoes were treated. Consequently, the culls could not be fed to stock and so were put into cull piles. The late blight fungus was found fruiting on such piles on the east end of the Island.

The tomato plants sent from the South also were affected by the potato late blight fungus. A few shipments showed a large percentage of these plants injured, and in at least one case, 125 acres of crop had to be plowed under. One shipment of plants was suspected of being affected by Phytophthora infestans, but when scrapings were made and placed under the microscope, it was found that the fungus was Phytophthora terrestris rather than Phytophthora infestans. The weather is cold and wet so that we shall be interested in watching the further development of blight in fields planted from such seedlings.

NEW YORK STATE COLLEGE OF AGRICULTURE, ITHACA
June 21, 1946

LATE BLIGHT ON TOMATO IN NEW YORK

Otto A. Reinking and W. T. Schroeder

The disease was first noted on seedling plants shipped from the South which arrived in Geneva on May 23, 1946. The disease was present before the plants were set out in the field. Plants sent in from a western State did not have the disease. We only have noted the disease on plants shipped into the State from outside sources. It would appear that the original source of infection in this instance was in the South on seedling plants. A large acreage of tomato plants was plowed under because of injury to the plants by the fungus. This was the only control practiced.

In the past years, we have had downy mildew on tomato plants and fruit in the field. This disease usually appeared late in the season, was a local infection, and was easily controlled by spraying with various copper sprays.

A study of the fungus on the plants sent in from the South showed it undoubtedly to be Phytophthora infestans. Further studies are being made of the fungus. It was easily transmitted to healthy plants where it produced a severe blight.

NEW YORK STATE AGRICULTURAL EXPERIMENT STATION, GENEVA
June 20, 1946

LATE BLIGHT ON TOMATO AND POTATO IN PENNSYLVANIA

R. S. Kirby

Late blight has occurred on both tomato and potato. On tomatoes, it is severe in practically every important tomato-growing section. It has spread rapidly in the field from plant to plant and has caused many growers to replant their fields several times. In a number of cases, entire fields have been plowed down. In Schuylkill County, over 700 acres of tomatoes have been plowed down that were killed with blight and in many other counties hundreds of thousands of plants were lost. The disease kills the tomato plants in the field. In a number of cases it has even caused rot of fruit just beginning to form.

On potatoes, Dr. O. D. Burke first found late blight on sprouts on a cull pile. Later blight was observed spreading from infected tomato fields to potato fields.

Spraying with fixed coppers or Bordeaux, or dusting with fixed copper dusts, is being advised to control the disease.

The disease was first found on tomatoes on May 21 in Columbia County. Since that time, it has been found in at least 20 additional counties in all parts of the State.

On potatoes, late blight was first found on July 8.

On tomatoes, late blight apparently came in with the plants from the South. Surveys in many fields indicate that at the start there was no blight on home-grown tomatoes but where home-grown tomato plants were planted close to Southern plants, blight infected the home-grown plants.

On potatoes, the first blight was found on a cull pile but later there were many instances where late blight spread from infected tomato fields to potato fields.

PENNSYLVANIA STATE COLLEGE
June 18, 1946

LATE BLIGHT ON POTATO IN WEST VIRGINIA

H. L. Barnett

The following information on the late blight situation in West Virginia has been furnished by Mr. C. F. Bishop, Extension Pathologist.

Late blight on potatoes is now widespread in West Virginia, being first reported this season at Alpena on June 13. This is the earliest date on record for the appearance of late blight in the State. Since

that date it has been reported from nearly every county in the central mountainous region of the State and has already reached epiphytotic proportions. Cobblers, which ordinarily escape heavy damage, are already severely infected and there are definite indications that the early varieties will suffer considerable loss.

The usual recommendations have been Bordeaux, fixed coppers, and Dithane. The evidence indicates that the initial sources of inoculum are cull piles and volunteer potatoes in the field and garden.

No late blight on tomatoes has been reported at this date. However, conditions are favorable, and since it was severe in the mountainous regions of the State last year, there is every reason to expect that it will cause equal damage this season.

WEST VIRGINIA UNIVERSITY
June 25, 1946

LATE BLIGHT ON POTATO AND TOMATO IN OHIO

H. C. Young

Late blight first appeared on potatoes May 31 in the Marietta section. It is still prevalent but has not become serious even on untreated plots. The source of initial infection has not been determined except to state that the disease occurs every season, being more prevalent when May and June are wet and cool. It seldom causes an appreciable loss in this section.

Most southern tomato plants that we observed that came to Ohio after May 20 contained late blight. We began inspecting fields June 1 and by June 10 from 15 percent to 20 percent of the fields had to be reset. From 50 percent to 60 percent of the fields were spot reset. This, in many cases, has been repeated three and four times.

There are something over 30,000 acres of tomatoes grown for canning in Ohio. About 10,000 were set to locally grown greenhouse plants and by direct seeding. To date (June 20), late blight has not appeared on home-grown or direct seeded plants even though the weather has been wet and cool. Secondary lesions were noted on our June 10 inspection on shipped-in set plants. Georgia plants that were sent in before May 20 have shown little or no infection. Plants coming in from States north of the Georgia region are also showing late blight.

OHIO AGRICULTURAL EXPERIMENT STATION, WOOSTER
June 21, 1946

LATE BLIGHT ON TOMATO IN OHIO

T. H. King

So far the disease has been found and identified by us as being present in two counties. The disease was first noticed in Ottawa County on May 29, and in Washington County on June 26. However, it is possible that it is present in other parts of the State.

As far as I know the disease has occurred only on tomatoes so far. On the tomato plants from Washington County the disease is present on the plants that were grown locally, while in Ottawa County it was found on tomato plants that had been shipped from the South.

Control measures for the use of Bordeaux mixture, or fixed copper have been recommended to the growers.

OHIO STATE UNIVERSITY
June 27, 1946

LATE BLIGHT ON TOMATO AND POTATO IN INDIANA

R. W. Samson

I first identified late blight on incoming tomato plants from southern Georgia and western Tennessee on May 26. These plants were from unopened shipping containers collected from Indiana canners on May 23 and probably left the points of origin on or before May 20. The disease was subsequently noted on plants taken directly from shipping containers as received from Mississippi and southern Illinois. It was likewise identified on a small sample of plants submitted by an Indiana canner and originating in Virginia.

With one exception, no late blight has been found to date on tomato plants in Indiana direct-seeded fields or local plant beds and fields. The exception is the discovery of extensive late blight in direct seeding immediately adjacent to a field set early with southern-grown plants in which late blight was earlier noted.

Occasional to very numerous late blight stem cankers have been found in all fields examined that were set with plants from these southern sources. Some stands were almost totally destroyed by such infection. No estimate has yet been made of the general extent of such stand damage. Some secondary infections, appearing as well-developed leaf lesions, have already been noted in fields set early with southern-grown plants.

The advanced development of stem cankers in many fields indicates that late blight was present on tomato plants received from the South as early as May 3. At present, it seems safe to say that late blight infections are present in all Indiana tomato fields set entirely or partially with southern plants. To what extent these infections will harbor the fungus until abundant foliage growth provides humidity chambers to incubate a serious epidemic later remains to be seen. Late blight probably cut the Indiana canning tomato yield by at least 100,000 tons last year, the first year in which we have any record of the disease occurring on tomatoes in the State. It now seems more than probable that the disease was introduced on southern-grown plants last year, as the writer suggested but did not verify (PDR 29: 674-675. 1945).

A severe outbreak of late blight was discovered during the first week in June on fruiting tomatoes in a local greenhouse that had been poorly heated and ventilated. Infection is presumed to have come from a fall crop grown in the same house.

Late blight has been reported on very early potatoes in eastern and southern Indiana, with extensive damage in the latter section. Weather has been particularly favorable for both early, luxuriant development of potatoes and for late blight in those sections. Late blight has not yet been found in advanced early potato plantings in central Indiana where many of the blight-infested canning tomato fields are located that were set with southern plants.

The evidence is quite conclusive that the late blight now present in Indiana tomato fields set with southern plants was introduced on the plants.

Large-scale potato growers in Indiana are adequately equipped with spray machinery and experienced in its use. Home market gardeners are generally without suitable equipment to apply fungicides for blight control. Growers of cannery tomatoes are in a similar position. If a blight epidemic should threaten later, extensive use may be made of fungicides applied from airplanes to canning tomatoes. This method of application did not give any outstanding control of late blight in Indiana in 1945, possibly because applications were made too late.

In many instances where stands of tomatoes have not been seriously reduced by late blight, missing plants are being replaced with locally-grown plants. Some fields too severely damaged to warrant resetting by hand are being entirely replanted to tomatoes. A few would-be tomato growers have turned to corn or soybeans, after becoming aware of late blight, either abandoning infected acreage already set or not setting any more tomatoes.

PURDUE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION, LAFAYETTE
June 19, 1946

LATE BLIGHT IN SOUTHERN ILLINOIS

G. H. Boewe

So far, I have only examined potatoes and tomatoes in the southern third of Illinois.

Late Blight of Potatoes and Tomatoes in Southern Illinois, June 4-7, 1946

County	Size of Planting	Variety	Prevalence	Intensity
		Potato		
	acres			
Clark	1/4	Cobbler	0	
Gallatin	1/4	"	0	
Jackson	1	"	0	
Madison	8	"	100	Severe on leaves
"	6	"	100	Very severe on leaves
"	5	"	0	
Monroe	1	"	0	
"	10	"	0	
Pulaski	1/10	"	0	
"	1/8	"	100	Severe on leaves
"	1/8	"	100	" " "
"	10	"	90	35% of leaves
"	25	"	100	67% of leaves
Randolph	1	"	0	
Richland	1/8	"	1	Very light on leaves
Union	1	"	35	7% of leaves
Wabash	1/4	"	0	
		Tomato		
	plants			
Monroe	8,000	Rutgers	0	
"	4,000	"	100	30% of leaves
Pulaski	7,500	Bonny Best	Trace	(1% in small area in field)
"	1,800	" "	30	5% leaves, Tr.fruit
"	2,000	Earliana	100	Light on leaves
"	2,500	Bonny Best	100	Severe on leaves
"	4,000	" "	100	" " "

(Severe on green fruits on severely diseased plants in last two fields)

Late blight has been found on both potatoes and tomatoes in southern Illinois. I examined one planting of potatoes in each of the following counties: Clark, Wabash, Gallatin, Jackson and Randolph, and two plantings in Monroe, but found no late blight. Five plantings of potatoes were examined in Pulaski County and only one was free of late blight. In Madison County two plantings examined had 100 percent late blight infection and in one planting no blight was observed.

Late blight was observed on tomato plants set in the field and on plants in plant fields in Pulaski and Monroe Counties. Two fields of tomatoes (last two in table) in Pulaski County had 100 percent of the plants diseased and a large area in each field where the plants were severely infected, with cankers on branches and leaf petioles and the leaves mostly dead. Another planting had 30 percent of the plants with 5 percent of their leaves infected. Only three severely diseased plants were observed in this field. Another planting which was set out two weeks later than the above fields had 1 percent of the plants infected in a small area of the field.

Some of the largest potato growers have sprayed with Bordeaux or fixed copper but most growers have used no sprays or dusts. One tomato grower sprayed with Bordeaux (10-10-100) about 10 days before I saw the planting on June 6, 1946. He had noticeably checked the spread of the disease.

I saw the first authentic specimen of late blighton potato May 28. However, from the description given of leaf spot present on potatoes in Madison County on May 8, I believe the disease was present at that time. In Pulaski County the disease probably appeared as early as May 8 or possibly earlier. In some of the potato fields, infection probably came in with the seed. In the case of tomatoes in Pulaski and Monroe Counties the source of infection is not known. The Pulaski County growers bought certified seed and grew their own plants in hot beds. Some of the tomato plants that I saw were blighted worse than any of the potatoes in this area.

ILLINOIS STATE NATURAL HISTORY SURVEY DIVISION
June 18, 1946

LATE BLIGHT ON POTATO AND TOMATO IN ILLINOIS

M. B. Linn

A special release was sent to all Farm Advisers by the writer on May 20 warning them that conditions were favorable for potato late blight. On May 23 a radio talk was given on this subject over the University of Illinois Station WILL. On June 5 Illinois Farm Flash

No. 45 was sent to thirty-five radio stations in Illinois, Missouri, Kentucky, Indiana and elsewhere. So, all in all, we have given a considerable amount of publicity to late blight and its control. The Farm Adviser release and WILL talk were given before we knew that late blight was actually present in the State. We based our warning on cool temperatures and wet weather during May which were remarkably like those in May of 1945 when we had a less severe outbreak.

Although late blight was first reported on tomatoes, it is my belief that the disease developed first on garden plantings of potatoes and the spores were carried to tomatoes. We have no proof of this at all and no special effort has been made to trace outbreaks to the original source. So far as we know there were no importations of tomato plants into the areas where late blight first appeared -- at least not until after the disease was well established.

UNIVERSITY OF ILLINOIS
June 19, 1946

SOME BRIEF REPORTS OF OCCURRENCE ON POTATO

MAINE:

By Donald Folsom

In central and northern Maine tomatoes have been set out in the gardens for only a week or two. During the past two years all tomatoes were killed down by a frost on June 9th or 10th.

However, in Aroostook County, potato late blight was found on potato by Dr. E. S. Schultz on June 2; three dump piles were examined of which two were found to be producing late blight. According to Dr. Reiner Bonde the Aroostook County County Agent used this information for radio broadcasts and cull piles are being eradicated. At the last session of the legislature, or perhaps the one before that, a law was passed against potato dump piles but apparently the law is not enforced.
MAINE AGRICULTURAL EXPERIMENT STATION
June 18, 1946

WISCONSIN:

By R. E. Vaughan

Potato late blight fungus was found in good fruiting condition on volunteer potato plants from a discard pile in Waushara County, Wis-

consin on June 20. It has not been found in any field up to the present time. Steps are being taken to inform our county agents of the presence of late blight.
UNIVERSITY OF WISCONSIN
June 22, 1946

CALIFORNIA:

By M. W. Gardner

In the Colma market garden region, which I visited June 18, potatoes -- mainly Bliss -- have been grown more generally than usual and are now being harvested. These are grown under overhead sprinkler irrigation and this has resulted in considerable late blight infection, even though most growers sprayed with Bordeaux. There is also abundant infection on the common weed in the potato patches, *Solanum sarachoides*.
UNIVERSITY OF CALIFORNIA
June 19, 1946

PLANT DISEASE REPORTER SUPPLEMENT

Issued by

THE PLANT DISEASE SURVEY
DIVISION OF MYCOLOGY AND DISEASE SURVEY
Plant Industry Station Beltsville, Maryland

THE 1946 EPIPHYTOTIC OF LATE BLIGHT ON TOMATO

Plant Disease Reporter
Supplement 165 November 15, 1946

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THE 1946 EPIPHYTOTIC OF LATE BLIGHT ON TOMATO

Plant Disease Reporter
Supplement 165 November 15, 1946

SUMMARY

In order to present as complete a record as possible on the final outcome of the threatening tomato late blight outbreak reported in Supplement 164, the Survey asked its collaborators to summarize their information on certain phases of its development in their States. The answers are given in this Supplement. Since this summary deals primarily with late blight on tomato, reports of the disease on potato that were included in some of the answers will be placed in a future issue of the Plant Disease Reporter.

Certain specific questions asked in the request sent to collaborators are repeated below, with brief summaries of the answers to some of them.

1. Can you supply estimates of loss from your State?

Losses reported are listed in Table 1. It is of interest to note that in spite of the epiphytotic many States reported an unusually good crop.

Table 1. Losses from late blight on tomato, 1946. (See also map, Figure 1).

State	Loss reported
Alabama	75% early commercial crop (800 acres southeast) 25% late crop (8000 acres north and central)
Florida	40% Homestead area (Borders, PDR 30 (5): 170. May 15) 50% Palm Beach-Martin-Broward County area (Townsend et al. PDR 30 (7): 240. July 15)
Georgia	Early green wrap fields 60-70%; in late planted about 40%
South Carolina	From 10 to 65% in principal tomato-producing counties, average 55%
North Carolina	In Eastern, 5% early, 25% late crop Western, 90%, in home garden and commercial

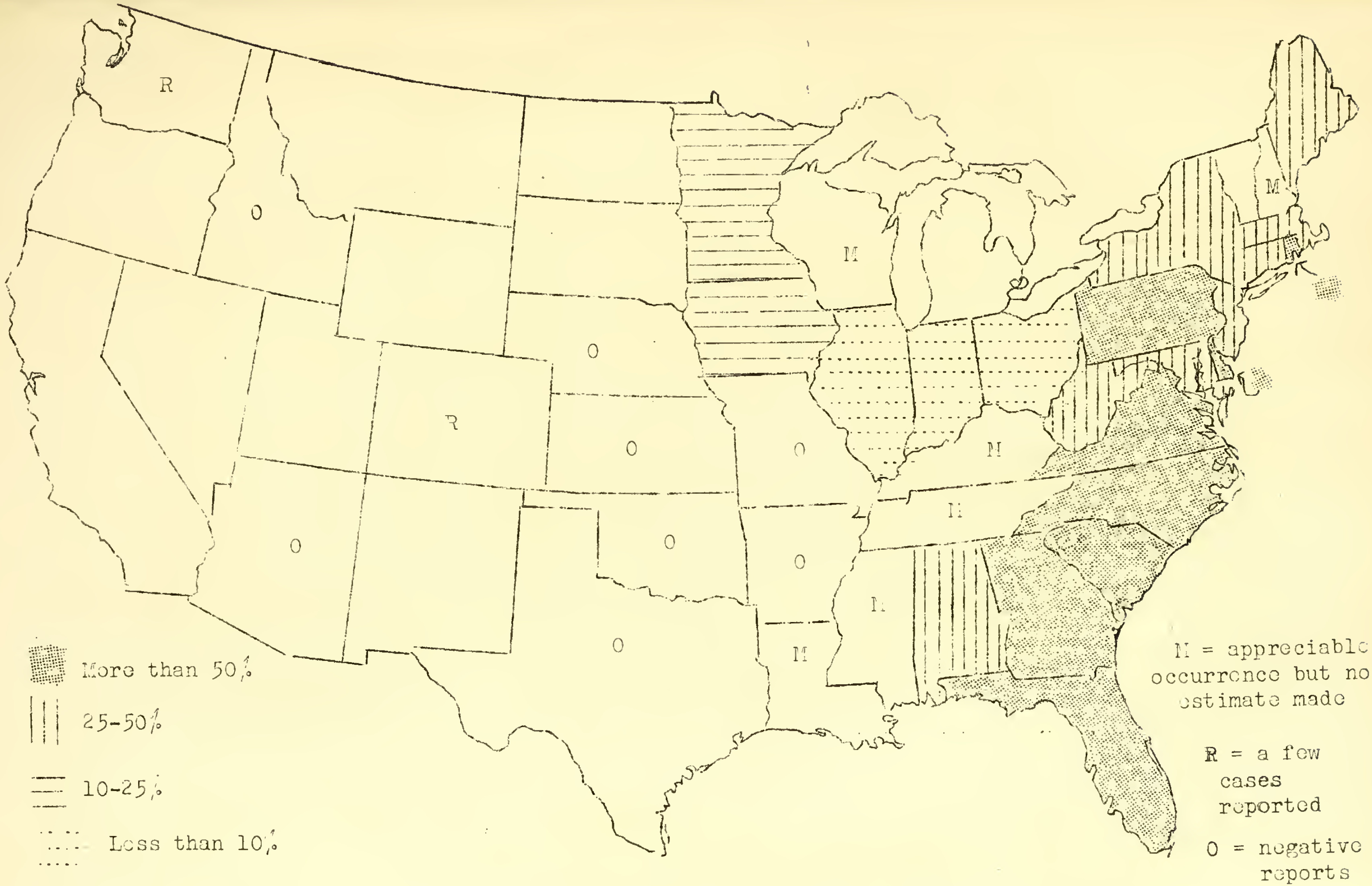

Figure 1. Loss from tomato late blight in 1946. (See also Table 1.)

Table 1. Losses, cont.

State	Loss reported
Virginia	Green wraps 75%; canning 50% In Norfolk-Eastern Shore area green wraps 75%; canning crop negligible
West Virginia	40-50%
Maryland	40% of potential crop
Pennsylvania	60% average, range 5-75%; severe on young plants and mature crop
Delaware	50% of potential yield, 3/4 of this loss on late, 1/4 on early and mid-season tomatoes
New Jersey	20-30% potential crop in south; 30-40% in central; 50-60% in north. Largest acreage in southern half
New York	Possibly 25%
Connecticut	25%
Rhode Island	70-90%
Massachusetts	50% commercial; 75% home garden
Maine	25-35%
Ohio	8% -- 3% fruit loss, 5% from plant stand. 3% loss in canning area, 20-25% staked tomato area. About 10% of fields reset to some degree
Indiana	Perhaps 10%, including early stand losses and subsequent foliage and fruit destruction.
Illinois	Less than 1%
Minnesota	10-20%
Iowa	15%

2. Was the loss on young plants or did it occur on the mature crop?

In general, major damage was to maturing plants, from yield reduction and fruit infection. However, in many States infection of young plants, whether imported or home-grown, was severe and caused a considerable amount of replanting and some abandonment.

3. What control measures were taken?

Table 2 lists the materials used for spraying or dusting in the States reporting on control measures.

Table 2. Fungicides used for the control of tomato late blight, 1946

Spraying materials reported	State	Dusting materials reported	State
Dithane plus zinc-lime	Florida	Fixed copper compounds	Maryland
	Delaware		Pennsylvania
			West Virginia
Fixed copper compounds	Maryland		Ohio
	Pennsylvania		Illinois
	North Carolina		North Carolina
			South Carolina
Neutral copper	Delaware		
	Massachusetts	Neutral copper	Delaware
			Massachusetts
Metallic copper	Ohio		Maine
Dithane Reaction Product (He 178e)	Delaware	Bordeaux	Massachusetts
		Copper-lime	West Virginia
Dithane	Connecticut	Copper	Virginia
	Massachusetts		Indiana
	Alabama		
Phygon	Connecticut	Insoluble copper	New York
Bordeaux	Connecticut		
	Massachusetts		
	Maine		
	Virginia		
	West Virginia		
	Ohio		
	Pennsylvania		

Table 2. Fungicides, cont.

Spraying materials reported	State	
Fermate or Zerlate and Bordeaux in staggered program	New York	
Insoluble copper	New York	

4. Which gave better results, spraying or dusting?

Most of the answers commenting on this subject reported spraying as more effective. Generally, however, lack of equipment and late starting, rather than type of application, were responsible for poor control.

5. If dusting was done by airplane was it effective?

See Table 3. As with other methods of application, late starting was partly responsible for mediocre results.

Table 3. Effectiveness of airplane dusting for control of tomato late blight, as reported in 1946.

State	Effectiveness of airplane dusting
Georgia	Less effective than tractor dusting
South Carolina	In one case no basis for comparison; in another, both plane and power dusting moderately successful
Virginia	Not very effective
Maryland	Most dust applied with airplanes; results disappointing. One case spraying by airplane a failure.
Pennsylvania	Checked disease but less effective than ground dusting
Delaware	Last choice of methods

Table 3. Airplane dusting cont.

State	Effectiveness of airplane dusting
New Jersey	Last choice
New York	Airplane dusting effective where used -- started early
Ohio	Partially effective
Indiana	Dry weather confused results
Illinois	Believed effective

6. About what percentage of the growers in your State attempted control measures?

This is summarized in Table 4

Table 4. Percentage of growers attempting control of tomato late blight, 1946

State	Percent of growers using control
Louisiana	Probably none
Mississippi	Very few if any
Florida	Probably only the larger growers
Georgia	100% of plant growers; probably less than 1% of green-wrap growers
Alabama	Not many
South Carolina	10-15% of commercial acreage
North Carolina	Eastern 1% (including home gardeners) Western 10% (home gardeners and market gardeners)
Virginia	Very few; 5-10%
West Virginia	20% of growers = about 10% of acreage
Maryland	About 10% commercial acreage

Table 4. Growers attempting control, cont.

State	Percent of growers using control
Pennsylvania	Very few equipped; 20% tried but only 5% with proper equipment
Delaware	10% of growers = 15% acreage
New Jersey	Not known but practically entire supply of suitable spray materials bought out during tomato season
New York	Not known. Growers not equipped
Connecticut	Very few
Rhode Island	Very few -- not prepared
Massachusetts	5-10%
New Hampshire	About 10% (home gardeners)
Maine	5%
Ohio	10%; in canning area about 50%
Indiana	See text
Wisconsin	Probably none
Minnesota	Only a fraction
Iowa	None

7. Are you preparing expanded control facilities for possible use next year?

For the most part the answer is "Yes", at least to the extent of watching for threatening infections and warning growers in time to take preventive measures.

8. Do you have any specific observations on the manner of dissemination this season?

9. Can you correlate weather variation with fluctuations in the disease?

10. Did you observe any differences in varietal reactions?

The reader is referred to the various reports for discussions on these three topics.

11. Did you observe the late blight fungus on hosts other than tomatoes and potatoes?

Since "No" is the general response to this question it is omitted from most of the answers. In New Jersey peppers showed suspicious symptoms but the cause could not be determined. Infection of pepper was reported from Indiana. In Supplement 164 Solanum sarachoides was reported to be a carry-over host in California potato fields.

STATE REPORTS

TOMATO LATE BLIGHT IN LOUISIANA

L. H. Person

There is very little further information regarding the seriousness of late blight and losses from it in this State. We had no reports of a serious disease from county agents or growers from our small commercial area; therefore I would surmise that no serious outbreak occurred there.

The following answers are based on observations made on the Experiment Station plots and in gardens in the vicinity of Baton Rouge.

1. No loss estimates are available.

2. Losses occurred primarily on the mature crop (infection on fruits).

3. No control measures were taken.

6. Probably no growers attempted control.

9. The disease developed during a cool, continued rainy spell, and became less noticeable as the weather cleared and it became warmer.

Most of the commercial area is planted somewhat later than the plots examined by me and probably escaped serious damage, as the crop would have matured under more favorable growing conditions.

LOUISIANA STATE UNIVERSITY
BATON ROUGE. OCTOBER 16

TOMATO LATE BLIGHT IN MISSISSIPPI

John T. Presley

(See also PDR 30 (9): 340-341. September 15)

1. We are unable to supply estimates of loss from our State.

2. The loss occurred on the mature crop rather than on young plants.

3. Very little if any control measures were taken.

7. We are preparing to inaugurate a control program for next year, principally in the Crystal Springs area.

8. We do not have specific observations on the manner of dissemination this season but all evidence points to the organism being windborne.

9. There was a definite correlation between weather and fluctuations in the disease, with late blight appearing in most severe form during rainy periods and becoming appreciably less destructive following a few days of clear weather.

10. We did not observe differences in varietal reaction but certain lines carried at the Crystal Springs Station were definitely more resistant that others.

MISSISSIPPI AGRICULTURAL EXPERIMENT STATION
STATE COLLEGE. OCTOBER 14

TOMATO LATE BLIGHT IN KENTUCKY

W. D. Valleau

I made no study of the disease but fruits that were decaying were sent in from several parts of the State. The disease usually commenced as leaf infections and finally destroyed the majority of the fruits remaining on the plants after the leaves were practically dried up. Some gardens escaped nearly completely.

KENTUCKY AGRICULTURAL EXPERIMENT STATION
LEXINGTON. OCTOBER 1

TOMATO LATE BLIGHT IN TENNESSEE

J. O. Andes

We have no detailed information on late blight. However, the disease was destructive up to the end of the season, although during the dry part of the summer when temperatures were high there was not much complaint. In general, it may be stated that the disease was serious and widespread on potatoes and tomatoes. I regret that there are no exact figures on damage, but see no likely means of obtaining them, especially since most of the damage was in garden patches.

UNIVERSITY OF TENNESSEE
KNOXVILLE. OCTOBER 30

TOMATO LATE BLIGHT IN FLORIDA

W. B. Tisdale

1. Loss estimates are not available for the State as a whole. (See Table 1.)

2. Loss caused was to both young plants and mature crop.

3. Control was principally by spraying with Dithane plus zinc-lime.

4. Spraying gave better results than dusting.

5. We have no accurate data on airplane dusting.

6. Probably only the larger growers attempted control. Some of these were not equipped to spray.

7. For next year we are recommending Dithane and related products, and planning experimental tests.

8. A. L. Harrison has prepared an article for Phytopathology on tomato late blight dissemination.

10. Certain varieties showed some resistance.

FLORIDA AGRICULTURAL EXPERIMENT STATION
GAINESVILLE. OCTOBER 1

TOMATO LATE BLIGHT IN GEORGIA

Edward K. Vaughan

Dr. B. B. Higgins has referred your request for information on tomato late blight to me.

1. In early fields of "green wrap" tomatoes losses were probably 60 to 70 percent of the crop. Losses in late planted "green wraps" probably did not amount to more than 40 percent.

2. The late blight infection was first noticed on "green wraps" but caused considerable damage on both young plants in the field which were being grown for shipment to northern growers and on the mature plants.

3. Except in the tomato plant fields practically no control measures were used because the disease was not recognized by most growers until it was too late to control it effectively, and because most growers did not have any equipment for applying sprays. All of the tomato plant fields were either sprayed or dusted but control left much to be desired. Complaints received from northern canning companies and northern tomato farmers indicate that a considerable amount of disease was present in the plants at the time that they were shipped.

5. In general, I believe dusting with tractors was much more effective than airplane dusting.

6. One hundred percent of the tomato plant growers applied control measures but probably less than 1 percent of the growers of "green wrap" tomatoes made any attempt to control the disease.

7. Certification of seedling tomato plants already requires that all fields be dusted or sprayed with proper fungicides at seven- to ten-day intervals. Because of the seriousness of the disease situation in 1946 plant growers should devote special care to the thoroughness and timeliness of fungicide applications in 1947. It is probable that the majority of seedling fields will be dusted rather than sprayed next season. Since late blight has never occurred in two successive seasons in Georgia, the green-wrap tomato growers do not anticipate that it will this time and there probably will be little spraying or dusting of the market crop.

9. During periods of warm dry weather the disease did not die out but it ceased spreading and caused no further damage in fields of mature tomatoes. However, as soon as we had three or four rainy days it again spread like wildfire.

Late blight came into the plant producing area late in the season but caused very appreciable losses during the short time that it was present. I doubt that any load of plants leaving the state after May 20 was entirely free from incipient infections.

U. S. BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING
DIVISION OF FRUIT AND VEGETABLE CROPS AND DISEASES
TIFTON, GEORGIA, OCTOBER 11

LATE BLIGHT ON TOMATOES IN ALABAMA, 1946

Coyt Wilson and J. L. Seal

Late blight caused losses of 75 percent or more of Alabama's early crop of commercial tomatoes in 1946. The early plantings amounted to about 500 acres in Southeastern Alabama. The disease appeared to spread from potatoes to tomatoes in May, during periods of heavy rainfall. Very few of the growers were equipped to spray or dust properly, and before equipment and materials could be obtained, serious damage had been done.

The late crop of tomatoes, totaling slightly over 8,000 acres in Northern and Central Alabama, suffered less damage. Rainfall was less, temperatures were higher, and a few of the growers, being forewarned, followed a dusting or spraying program that reduced the damage considerably. Late blight appeared on the plants of the late tomatoes soon after they were set in the field, but, as was true of the early crop, most of the damage was on the mature plants and the ripening fruit. John Bagby, Extension Specialist in Fruit and Vegetable Marketing, estimates that the loss on these tomatoes was approximately 25 percent. This would bring the total loss of commercial tomatoes for the State to approximately 220,000 bushels. Tomatoes in home gardens also suffered considerable damage.

There are no accurate data on the percentage of growers who attempted control measures. Most people did very little or nothing toward controlling the disease. Excellent results were obtained with Dithane spray by one or two growers in central Alabama. Where a thorough job of dusting was done, the results were equally good. It is expected that a high percentage of the tomatoes in Alabama will be dusted next year. Small plantings, less than 10 acres, are the rule, and consequently, very few producers will feel justified in purchasing expensive power sprayers.

In most instances, late blight appeared first in fields reasonably close to infected potatoes. However, the disease did appear in some fields located a mile or more from any potatoes. Dissemination by wind from field to field evidently played an important role.

There was no apparent difference in susceptibility among the standard field varieties. Some selections on the Alabama Agricultural Experiment Station plots at Auburn showed considerably more resistance than some of the commonly grown varieties.

Phytophthora infestans was not observed on any plants other than potatoes and tomatoes this year, but no extensive surveys were made.

ALABAMA AGRICULTURAL EXPERIMENT STATION

TOMATO LATE BLIGHT IN SOUTH CAROLINA

William M. Epps

Late blight appeared on potatoes in South Carolina about the first of May just as early harvesting was beginning. It spread slowly and losses to the potato crop were slight. Very soon afterwards it appeared on tomatoes in the potato-growing coastal area and in Orangeburg County. Later in the month it appeared in Dillon County. The weather during the most of May was relatively cool with several periods of damp cool weather favorable for the spread of late blight. The advent of hot dry weather early in June completely checked the disease in all of the commercial tomato-producing areas of the State; so that few actively sporulating lesions could be found by the middle of the month.

The damage caused by late blight of tomatoes in South Carolina in 1946 was widespread over the entire State. Losses amounted to almost nothing on certain farms and were almost complete on others. Losses to commercial plantings varied from a low of about 10 percent for Dillon County to a high of about 65 percent in Orangeburg County. The average loss for the entire State due to this disease was about 55 percent. This figure represents a weighted average of loss estimates from the county farm agents in the principal tomato-producing counties. In addition to the damage caused on farms where tomatoes are grown commercially, losses in home gardens were quite general over the State. No attempt was made to estimate the loss in these home gardens.

The loss on tomatoes occurred largely to plants that were nearing maturity. In most parts of the State the disease appeared during the latter half of May from one to two weeks before picking began. The early crop of fruit over the entire area was severely damaged by fruit rot. Damage to the later crop was dependent on the amount of foliage damage caused. In some sections, notably in Dillon County, the damage was largely limited to a rotting of the early fruit. The foliage was not seriously damaged and the later crop was quite good. The losses in such fields were relatively small, estimated at about 10 percent by the Dillon County Agent. In other sections, as at the Truck Station at Charleston and in Orangeburg County, damage to the foliage in many fields was so severe that the later fruits either failed to develop to adequate size or else were badly sunburned and the crop was almost a total loss, even though a period of hot dry weather in early June checked the disease almost completely.

The application of copper fungicides to tomatoes has in past years proved to be of no value in increasing the yields of tomatoes in Coastal South Carolina. Therefore, no fungicide has been applied to the crop at the time the late blight appeared. A fixed copper dust containing

6 percent metallic copper was recommended for use on fields where the disease had not become established. This dust was used by a few growers with variable results. The county agent of Orangeburg County wrote that approximately 5 percent of the farmers in his county used a copper dust, but most of these men started dusting after the disease had become established. Their results were not very encouraging. In Beaufort and Charleston Counties about 50 percent of the tomatoes were dusted. No fungicide was used in Dillon County. It is estimated that only 10 to 15 percent of the commercial tomato acreage in South Carolina received one or more applications of a copper fungicide. In the few known cases where dust was properly applied before blight became established, satisfactory control was obtained. With few exceptions, tomatoes are grown in relatively small acreages as a secondary crop on cotton farms or cotton and tobacco farms. Few of these growers are equipped with adequate dusting or spraying machinery. Only a few larger truck farmers in the coastal truck region have such equipment and it was only on these farms where a satisfactory job of dusting was done.

No instance is known where copper was applied as a spray; so that there has been no opportunity to compare the effectiveness of the spray with that of the dust. Airplane dusting was used on one large farm in Charleston County and at least one in Beaufort County. On the Charleston County farm 4 to 5 applications of a 6 percent fixed copper dust were made within the three weeks after late blight appeared. Effective control was obtained; while a neighbor, a small grower who used no fungicide, lost his entire crop. No power or hand dusters were used in that vicinity so that it was impossible to compare them with the airplane. In Beaufort County both airplane and power dusting were used with only moderate success. The two methods appeared to be about equally effective.

A fixed copper dust containing 6 percent metallic copper will be recommended for use in 1947 only if late blight should threaten. It does not seem advisable to recommend the routine application of copper to tomatoes on the chance that late blight might appear. It will be recommended, however, that those growers, who normally find it necessary to apply an insecticide dust, should incorporate the copper into that dust. A careful check will be made at frequent intervals and contact will be maintained with the Florida and Georgia Stations and, in the event the disease should threaten, the State extension service will be notified and dusting can be started before late blight becomes established in the State. The same fixed copper dust is now recommended for use on potatoes and cucumbers and a supply should be readily available locally on short notice.

Resistance to late blight was noted in several varieties and in many of the breeding lines of the Truck Experiment Station. The most resistant varieties were Garden State and selections from Targinnie Red. Most of the resistant breeding lines apparently inherited their resistance

from either the currant tomato, Lycopersicon pimpinellifolium, or Targinnie Red. Several lines, however, that resulted from crosses involving only susceptible parents, showed some resistance. The resistance appeared to be limited to foliage resistance, since the fruits of all lines, with the possible exception of some of the Targinnie Red selections, appeared equally susceptible. The apparent resistance of the Targinnie Red might be attributed to sparse foliage, to the lateness of the selections, or to their tough skin. Thus, even though some variations in susceptibility were noted, no immune or highly resistant material was found and no definite resistance to the fruit rot phase was found.

Late blight lesions were present thoughout the summer on the summer and fall plantings at the Truck Station at Charleston. Observations made on October 17, 1946, indicated that blight was present and was causing considerable damage to fall tomatoes in the station planting. It had not yet become generally distributed over the field.

SOUTH CAROLINA TRUCK EXPERIMENT STATION
CHARLESTON, SOUTH CAROLINA, OCTOBER 18

LATE BLIGHT OF TOMATOES IN EASTERN NORTH CAROLINA

D. E. Ellis

As reported earlier, late blight occurred generally on tomatoes in Eastern North Carolina up to about June 6, when its development was checked by warm weather. The disease remained quiescent until late August when it again became active. It has caused extensive damage to fall plantings mostly in home gardens throughout the area. Losses in the early crop are estimated at about 5 percent and to the late crop at 25 percent. Losses were largely confined to the mature crop but younger plants were affected to some extent. Copper dusts were used much more extensively than sprays but most growers started dusting too late to obtain effective control and it is estimated that less than 1 percent of the growers (including home gardeners) made any attempt to control the disease.

UNIVERSITY OF NORTH CAROLINA
RALEIGH, OCTOBER 30

LATE BLIGHT OF TOMATOES IN WESTERN NORTH CAROLINA

H. R. Garriss

As reported earlier late blight occurred unusually early in the Upper Piedmont and Mountain Areas in 1946. By the first week in June the disease had already caused severe damage on early set tomatoes and in most plant beds in the Southwestern Counties. Severe damage from blight occurred generally throughout the Mountain Area and Upper Piedmont through the summer and early fall. Losses in home garden and commercial plantings for local markets are estimated at 90 percent of the crop.

Fixed copper dusts and sprays were used by 10 percent of the home gardeners and local market gardeners in the Mountain Area. However, applications were not generally begun in time on the early crop to check the disease satisfactorily. Both dusts and sprays gave satisfactory control where properly used on later plantings.

Results obtained by many growers who dusted or sprayed properly in 1946 substantiate claims that fixed copper fungicides will adequately control late blight of tomatoes when applied thoroughly and timely. The Extension program for control of tomato late blight will be expanded in 1947.

UNIVERSITY OF NORTH CAROLINA
RALEIGH, OCTOBER 30

FINAL REPORT ON TOMATO LATE BLIGHT IN VIRGINIA - 1946

S. B. Fenne

The final estimates of the loss caused by tomato late blight during the past season are: green wraps - 75 percent, and canning tomatoes - 50 percent. There was, of course, considerable variation in the severity of the disease in different counties and even in different parts of counties. The loss was primarily confined to maturing crops.

Control measures were recommended at the very beginning of the season and publicity was continued throughout the season. A considerable number of home gardeners either dusted or sprayed their tomatoes and a few commercial growers did likewise. Where dusting with copper was started early and the leaves kept covered, satisfactory control was obtained. Best results, however, were obtained by the use of Bordeaux mixture. In many cases Bordeaux checked late blight even after it had developed to a considerable extent on the plant. Perhaps

from 5 to 10 percent of the growers in the State attempted some form of control. However, in most cases, the fungicide was applied too late by inadequate equipment, and in an insufficient number of applications. Growers and home gardeners have been warned that tomato late blight may appear again next year and if it does, they should be prepared to spray or dust.

From numerous observations made during the past season, it appears that tomato late blight was much more severe in those fields adjacent to or nearby potatoes. Late blight appeared early on potatoes throughout the State. Weather conditions were ideal for the development of the disease and in some cases it spread rapidly to tomatoes. During the latter part of August a period of dry weather set in and in most parts of the State the disease was immediately checked to the extent that some tomatoes were produced on formerly heavily diseased plants. However, since the inoculum was present, the disease reappeared after each shower of rain, and late blight is still active throughout Southwest Virginia and doing considerable damage. There have been no observations made on the difference of susceptibility amongst varieties; nor have any other hosts of the late blight fungus been observed.

VIRGINIA POLYTECHNIC INSTITUTE
BLACKSBURG, VIRGINIA, OCTOBER 8

TOMATO LATE BLIGHT IN THE NORFOLK AND EASTERN SHORE AREAS OF VIRGINIA

Harold T. Cook

Mr. S. B. Fenne has sent a report covering his observations in various parts of the State. My report will cover only the Norfolk and Eastern Shore area and will differ in some details from his report.

1. Estimated loss. -- Loss to the early or green wrap crop was about 75 percent. In many fields it was practically 100 percent and the crop was plowed under without picking any fruit. Loss to the canning crop was practically negligible. The disease nearly disappeared about the end of July and an excellent yield of healthier than normal fruit was obtained.

2. Age of plants. -- Loss in the early crop was from reduction in foliage and from infection of the fruit. Probably infection of the fruit was the most serious damage. Damage to the main crop was mostly from reduced foliage and some stunting, but the yield was apparently not greatly affected.

3, 4, 6. Growers were advised to spray or dust when it became

evident that low temperatures and high rainfall were going to continue into the summer. Very few of them practiced control measures and no information is available on the results that were obtained. Most of the damage had been done to the early crop before control measures were advised and the disease was on the decrease before they could be applied to the main crop.

5. No data are available on the results of airplane dusting. Recent dusting of fall potatoes by plane indicates that that method of application is not too effective.

7. Standard recommendations for spraying or dusting will be made next season providing weather conditions are favorable for blight development. No general recommendation to spray is planned at present since blight is seldom important on tomatoes in Eastern Virginia.

9. The development of blight this year appears to be definitely correlated with abnormal temperature and rainfall. Studies are being made of this correlation and will be reported later.

10, 11. No observations were made on varietal differences or of the occurrence on hosts other than tomatoes and potatoes.

VIRGINIA TRUCK EXPERIMENT STATION
NORFOLK, VIRGINIA, OCTOBER 21

TOMATO LATE BLIGHT IN WEST VIRGINIA

H. L. Barnett

The following information regarding late blight on tomato and potato in West Virginia during the past season was furnished by Mr. C. F. Bishop and Mr. J. R. Vaughn.

Late blight on tomato may be summarized by briefly answering the questions in your recent letter as follows:

1. The estimated loss over the entire State averaged 40 to 50 percent of the tomato fruits.
2. Loss was to the mature crop; no infection of young plants was observed.
3. The most common control practices were dusting with fixed copper dust or copper-lime dust, and spraying with Bordeaux mixture. Attempts at control were rather spotted and often hapazard. No control measures were taken in the largest tomato-growing areas, since they are located in areas which previous to this year have escaped late blight.
4. In general, spraying gave the better results. However, when dust

was properly applied to achieve adequate coverage and was applied frequently enough, good control was obtained.

5. No dusting was done by plane.

6. An estimated 20 percent of the growers attempted control measures. This represented approximately 10 percent of the tomato acreage in the State.

7. Plans are being made for expanding the control program along three major lines: (a) Custom spraying and dusting; (b) Close cooperation between manufacturers, dealers and the Agricultural Experiment Station to provide more adequate and orderly distribution of control materials; (c) More demonstration plots showing the use of the more effective spray materials.

8. No specific observations were made on the manner of dissemination.

9. In areas where late blight occurred it developed when weather conditions were very favorable. Under the dry conditions during late summer the blight was checked.

10. No varietal differences were observed on tomatoes.

WEST VIRGINIA UNIVERSITY
MORGANTOWN, WEST VIRGINIA, OCTOBER 14

TOMATO LATE BLIGHT IN MARYLAND

R. A. Jehle, F. C. Stark, and C. E. Cox

Late blight of tomatoes was first observed in the three lower counties on the Eastern Shore on June 6. At that time, while a trace of late blight was found in every field visited, it was most severe in tomato fields adjacent to severely affected potato fields. The indication was that potatoes had served as the original source of inoculum. Apparently there was little early spread of the disease out of these three counties as late blight did not appear in serious proportions in the other Eastern Shore counties until later in the season.

During the last of June and early in July late blight appeared in Harford County and the upper part of Baltimore County and soon afterward appeared in other counties of the northern tier. The indication was that it may have spread into these areas from Pennsylvania to the north rather than upward from the Eastern Shore. The disease apparently spread gradually southward through central Maryland, appearing on the western shore in Southern Maryland in August. Spread of the disease followed the abnormal occurrence of cool nights with heavy dews throughout the Piedmont regions and Southern Maryland. In extreme Western Maryland, where drought conditions were general and no late blight was observed on potatoes, the disease appeared in a mild form in most tomato plantings. In home gardens where close planting or a heavy growth of

weeds prevented rapid drying of the plants, late blight was severe.

It has been estimated that 40 percent of the potential 1946 crop of tomatoes was lost as a result of late blight. Had late blight not appeared, a bumper crop of tomatoes was indicated. For the most part, fields which escaped or in which late blight was controlled yielded crops well in excess of the 10-year average. On the lower Eastern Shore as well as in the more northern counties losses in some fields approached 100 percent. Such losses were quite prevalent in Worcester County where potatoes are extensively grown.

All of the losses reported in Maryland were from fruit rots and defoliation of mature plants. No cases were observed or reported in which young plants were so severely attacked as to necessitate replanting.

Approximately 10 percent of the total commercial acreage was sprayed or dusted with fixed copper compounds. Orchard sprayers were used extensively in one county with good results. Dusting was more widely practiced than spraying. Some dust was applied with row-type bean dusters but most of it was applied with airplanes. Airplane dusting generally gave disappointing results and the one case in which airplane spraying was tried was a failure. Lack of proper equipment was probably the chief factor that limited the wider application of fungicides. Lack of experience in using fungicides on tomatoes and failure to apply them soon enough were probably chiefly responsible for the disappointing results experienced by many growers. When the first application was made in time and where good coverage was maintained by three or four additional applications, good control of the disease was obtained with fixed copper sprays or dusts.

Growers and canners are being urged to make preparations now to apply fungicides next year should late blight appear.

No differences in varietal reactions were observed.

The late blight fungus was not observed on plants other than tomatoes and potatoes.

UNIVERSITY OF MARYLAND
COLLEGE PARK, MARYLAND, OCTOBER 19

TOMATO LATE BLIGHT SITUATION IN PENNSYLVANIA, 1946

R. S. Kirby

1. The average loss from late blight in Pennsylvania in 1946 is estimated at about 60 percent. The loss ran as high as 90 to 95 percent in some south central counties like Bedford, Blair and Juniata and was as low as 5 percent in Erie County.

2. Loss on Young Tomato Plants: Late blight was found on May 21 on heeled-in tomato plants in Columbia County. Survey of over a hundred tomato fields in May and June showed that late blight was carried into a large proportion of the fields on young plants. Wet cool weather enabled the fungus to spread in the fields and kill out many small plants. In numerous fields growers had to replant two or three times and set 6,000 to 9,000 plants per acre instead of the normal 3,000 plants. In Columbia County over 200,000 young plants were killed with blight. In Schuylkill County blight killed so many young plants that 700 acres were plowed down. Late blight was very severe on the mature crop.

3. Control measures taken: As soon as late blight was found news articles were sent out. On June 12 a spray letter was sent in all commercial tomato growing counties to tomato growers urging them to spray or dust at once all tomato fields in which late blight was present. A careful check on blight was maintained and a second spray letter was sent to tomato growers on July 10 and a third letter on August 2. A general summary of the tomato late blight situation was prepared and over 6,000 copies were distributed early in August.

4. Spraying was more effective than dusting but growers who dusted often enough and maintained coverage saved a good proportion of their crop. Sprays were needed at 7- to 10-day intervals and dusts at 3- to 6-day intervals.

5. Airplane dusting checked blight but was apparently not quite as effective as ground dusting. It appeared that the airplane operators did not get enough dust on the plants.

6. Very few growers were equipped to spray or dust. Twenty percent tried some spraying or dusting but only about 5 percent had equipment to do the job properly. In Luzerne County two tomato spray rings were started in 1946. These did a very fine job and excellent blight control was obtained. [See report by Weaver and Burke, page 344]

7. For 1947 growers will be urged to plant tomatoes either in (1) rows 5 1/2 to 6 feet between, or (2) leave driveways every 12 to 14 rows in the field so the tomatoes can be sprayed with row crop sprayers,

or (3) plant tomatoes in narrow fields so they can be sprayed with orchard equipment. A tentative spray schedule will be put out and a careful watch will be maintained for late blight. Tomato spray service letters will be sent out as in 1946.

8. The fungus causing late blight was apparently wind-borne. It became destructive first in fields planted with infected plants and appeared much later in fields planted with blight-free plants. (Late June to early August).

9. Weather conditions constituted one of the most important factors. Dry periods in June and July checked the disease in certain areas such as Berks and Lehigh Counties, while nearby counties like Chester with more rainfall had severe loss in July. A dry period in late September and early October checked blight and allowed many late ripening tomatoes to mature.

10. There were no striking differences between the common canning varieties grown in the State.

11. Late blight was not observed on hosts other than tomato and potato.

PENNSYLVANIA STATE COLLEGE
STATE COLLEGE

LATE BLIGHT OF TOMATOES IN DELAWARE - 1946

J. W. Heuberger

Late blight disease caused a loss of approximately 50 percent of the potential yield. Three-quarters of the loss occurred on late tomatoes and one-quarter on early and mid-season tomatoes. In individual fields, losses ranged from a trace to 50 percent on early and mid-season tomatoes, whereas on late tomatoes losses ranged from 80 to 100 percent of the crop. Losses were entirely on the mature crop. As late blight did not appear in epidemic proportions until July 10, no loss of seedlings was experienced.

Late blight was first found on tomatoes on May 29 in two fields, both of which were planted with southern plants. The disease did not spread to adjacent fields from these two sources of infection, even through weather conditions during early June were favorable for the development of the disease. The initial heavy wave of late blight infection occurred during the first week of July. Weather conditions during the last few days of June and the first part of July were favorable for late blight infection (heavy rains from June 28 extending

through July 2, accompanied by cool weather). Infection developed rapidly until by July 12 tomatoes were seriously affected, some fields showing heavy foliage infection and 50 percent fruit infection. On July 12 and 13 rainfall at Newark totalled 1.23 inches which, along with cool weather, permitted late blight development to continue at a rapid rate. When 2.85 inches of rain fell on July 23, it looked as though late blight would wipe out the tomato crop. Fortunately, however, the weather after July 22 turned off warm and dry until August 7, a period of 16 days. During this period, late blight "dried up" on the plants, except in low areas along the coast. A heavy rain on August 7, followed by a period of cool nights which permitted heavy dew formation, allowed late blight to start development again. Thus, a second wave of infection built up which practically wiped out the late tomato crop during the period of August 16 to 23. During this period temperature and rainfall (1.82 inches) were ideal for late blight development. Late blight development practically ceased after September 1 as it stayed dry from September 1 to 21. However, the damage had been done. The course of the disease in Delaware was directly correlated with periods of wet weather, warm days, and cool nights.

In connection with the first wave of infection (first part of July) it is interesting to note that this corresponded with a period of heavy foliage and fruit infection in the Cape Charles area of the lower end of the Delmarva Peninsula. This area lies approximately 75 miles south of Delaware. It is felt that the spores causing the initial wave of infection in Delaware were wind-borne spores from this area. This is supported by the fact that there was practically no local source of inoculum in Delaware.

Practically all tomatoes in Delaware for canning and fresh market are Rutgers. A few Marglobes are grown. Various varieties are found in home gardens. All varieties observed in Delaware were found susceptible to late blight disease.

The late blight fungus was only observed on tomato and potato in Delaware.

After late blight disease was found on tomatoes on May 29, weekly surveys of tomatoes and potatoes were made. No further cases of blight were found on tomatoes and only one case on potatoes, until the week of July 1. A news release containing pertinent facts on the fungus and its control was prepared on July 6. Also, visits were made to all canning companies in the State during the week of July 1 and control recommendations presented. Based on a report by H. I. Borders, Sub-Tropical Experiment Station, Homestead, Florida (PDR 30(5): 170-172. May 15, 1946), and on personal observations of the writer in Florida during February, 1946, Dithane plus zinc sulfate-lime spray was recommended as first choice, for control. The neutral copper sprays were second choice,

ground dusting with neutral copper dusts was third choice, and airplane dusting was fourth choice.

One canning company succeeded in getting 80 percent of their contracted acreage of early and mid-season tomatoes dusted by plane from one to seven times. Yields were, on the average, double in the treated fields. Some growers who dusted seven times with a neutral copper dust obtained a yield of 17 tons per acre. Certain growers who sprayed their early tomato fields seven times with Dithane + zinc sulfate-lime or a neutral copper obtained yields of 20 tons per acre. These fields were in areas where untreated fields were seriously damaged by late blight and yielded less than 5 tons per acre.

On the late tomato crop, five sprays with Dithane Reaction Product (He 178e) or with Copper Compound A gave yields of approximately 5 tons per acre whereas the yield on the untreated plants was less than 1/4 tons per acre.

From results obtained this season, the relative efficiency of various control methods appears to be as follows:

1. Ground spraying
2. Ground dusting
3. Airplane dusting

Considerable airplane dusting was done in Delaware during 1946. Where the first and succeeding applications were timed correctly, results were much better than expected -- control of late blight was quite good, particularly on the fruit. However, where the first application was timed too late, or where succeeding applications were spaced too far apart, airplane dusting gave poor control.

It is estimated that 10 percent of the growers, representing 15 percent of the acreage, attempted control measures. More growers would have attempted control if equipment had been available.

Many growers, particularly the larger ones, are making preparations to treat their acreage during 1947. Also, the tomato canning companies are making arrangements to have their contracted acreage treated during 1947.

Late blight has taught our tomato growers a lesson--that they must be equipped to use control measures if the disease reappears in future years.

Late blight was destructive on late potatoes in Delaware this fall. Many fields were completely destroyed. The fungus will have ample opportunity to overwinter on potato tubers and provide an abundant source of inoculum for 1947 if weather conditions next spring are conducive to late blight development.

UNIVERSITY OF DELAWARE
NEWARK, DELAWARE, OCTOBER 16

TOMATO LATE BLIGHT IN NEW JERSEY

C. M. Haenseler and B. H. Davis

(1) An accurate report on economic losses caused by late blight in New Jersey cannot be made but a summary compiled from estimates made by several Plant Pathologists, reports obtained from several large canners, surveys made by County Agricultural Agents and opinions of others familiar with the tomato situation, indicates that approximately 20 to 30 percent of the potential tomato crop was lost in the Southern New Jersey Counties, 30 to 40 percent in the Central Counties and 50 to 60 percent or possibly more in the northern market garden areas. Since the largest tomato acreage occurs in the southern half of the State, the total losses may be somewhat less than the mean of these estimated percentages would indicate.

The average State yield of tomatoes when finally reported may suggest that these estimated losses are too high. If this proves to be the case, as it probably will, the apparent discrepancy between State yield and estimated blight losses may be explained by the very high potential yields in 1946. In more normal seasons our losses from poor fruit set, anthracnose, blossom end rot, mosaic, soft rots, sun scald, drought, and August and September storms are rather high. This year, losses from these various causes were far less than usual. Consequently the total tonnage delivered to the canner or market this year may not give a true picture of crop loss caused by blight.

(2) We have no confirmed reports of losses in young plants. Late Blight appeared in New Jersey almost two months after canhouse plants were set. Although leaf blighting was abundant in some fields at that time, the major loss occurred later on the green fruit. Almost 100 percent of the crop was destroyed in some fields.

(3) Various methods of applying fungicides were used. Our recommendations were to use row sprayers if available, speed or other orchard sprayers as second choice, ground dusters as third best, and airplane applications if no other method was available.

(4) and (5) Personal observations as well as reports from growers and canners' field men all indicate that airplane dusting was very ineffective but we have no experimental data to show just how effective or ineffective the airplane applications were.

On the other hand replicated plots in tests sprayed at 10-day intervals with a 5-row ground sprayer were compared with adjacent plots receiving no fungicide. Almost perfect control of fruit rot was obtained in the sprayed plots. There was an average of less than one infected fruit per plant on plots that received a neutral copper spray

whereas an average of over 31 diseased fruits per plant occurred on the adjacent plot which received no fungicide.

(6) In the principal tomato area one large canner reported that 47 percent of his contracted acreage was sprayed. Another canner in an area where blight was slightly less serious due to lighter soils estimated that control measures, largely airplane dusting, were used on approximately 15 percent of the contracted acreage. No good estimate of the acreage treated throughout the State is available but it is significant that practically the entire supply of suitable spray materials available from New Jersey dealers was bought during the tomato season.

(7) Some of the canners are planning to make spraying and dusting equipment more available to their contractors in 1947 than it was in 1946. It has not been decided whether or not a general blight control program should be carried out by all growers next year. The program for 1947 may be one of preparedness so that control measures might be started on short notice if early spring reports from Florida, Georgia, and other States south of New Jersey indicate that a general blight epiphytotic may be expected. We plan to study all reports closely and to warn our growers to get ready to apply control measures if it should become necessary. As soon as the disease begins to develop in nearby States an alarm will be spread and all growers urged to apply fungicides regularly until it becomes evident that the disease is not spreading.

(8) We have no experimental data on the manner of dissemination. Although there were no confirmed cases of blight on seedlings imported into New Jersey, observations indicate that imported plants with incipient infection were set in some fields. Observations also indicate that there has been wide dissemination of spores by wind. The greater prevalence of blight early in the season in fields planted with southern-grown plants would suggest the former, while the total crop loss in many fields planted with home-grown plants and well isolated from either potatoes or southern-grown plants suggests that the latter must have been common.

(9) Weather conditions greatly influenced the blight in New Jersey. The disease in one section became very prevalent on foliage during a wet period in early July and then spread very little during a 2-week dry period in the middle of July. Spread occurred again during a rainy period, July 20 to 25. After August 7 an extended period of rainy humid weather resulted in rapid spread. The disease broke out in epiphytotic form about August 20. Local storms with cloudburst precipitation that occurred in certain sections of the State caused very heavy fruit infection in these specific areas. It was very evident that any condition that caused the soil or the microclimate about the base of the plants to remain very wet for a prolonged period greatly

increased the losses from blight. Some of these causes were:

(a) long heavy rains or frequent rains followed by a period of high humidity,
(b) very heavy soils,
(c) very heavy succulent plant growth,
(d) too close planting.

In areas with light sandy soils the average losses were less than on heavier soils but local weather conditions in some cases favored development of abundant infection even on very light soils.

(10) We had no opportunity to make a careful study of varietal susceptibility to blight but there was some evidence that on the average, Garden State and Pritchard varieties, with an open vine, had less fruit loss than Rutgers and Marglobe.

(11) Blight was not observed on any plants other than potato and tomato, although two suspected cases on peppers were reported. Both of these cases were investigated and were found to have foliage lesions unlike those caused by our common pepper leaf diseases. By the time the plants could be examined no conidiophores or spores of Phytophthora could be found. It cannot be definitely stated, therefore, that infection occurred on peppers.

NEW JERSEY AGRICULTURAL EXPERIMENT STATION
NEW BRUNSWICK, NEW JERSEY, OCTOBER 19

TOMATO LATE BLIGHT IN NEW YORK

Otto A. Reinking and W. T. Schroeder

1. We have no exact estimates of loss for the State. They varied from none to 100 percent. I should guess possibly that 25 percent of the crop was lost.

2. Our loss was on young plants sent in from Georgia and on the mature crop. The first loss we suffered was from infected young plants sent in from Georgia. Some 100 to 200 acres at least were plowed under from this introduction. However, we could not correlate the severe later infection on the mature crop with this first introduction. The severe loss came to the mature crop in the latter part of July and in August and September.

3. Our general control spray program for tomato diseases has been advised each year in areas where the leaf blights, anthracnose, and late blight have been severe. This included a staggered spray program

with Fermate or Zerlate and Bordeaux (4-2-50), or any one of the insoluble coppers at the rate of 4 pounds to 100 gallons of water for those compounds with approximately a 50% metallic copper content. The dusts advised were with one of the insoluble coppers, as above, at the rate of 14 pounds to 86 pounds diluent (talc or pyrax) with 40 to 70 pounds applied per acre.

4. Spraying gave better results.

5. We have a few instances in which dusting by airplane with one of the insoluble coppers was effective. In these cases, the dusting was started before the advent of disease and the operations were very thorough with heavy applications.

6. The percentage of growers attempting control measures is not known. The percentage of those carrying out a complete schedule was low because most growers were not set up for spraying or dusting, Many applied sprays and dusts after the disease had gained a good foothold and then with orchard sprayers or dusters and by airplane.

7. Expanded control facilities for next year are being prepared,

8. We have no observations on the current seasons dissemination. We have transmitted with ease the disease from current season potatoes and tomatoes to tomatoes in the greenhouse. In these tests, there appeared to be no difference in virulence in the fungi collected from both hosts.

9. We believe that the cold August, 5° F below normal, and the widespread drizzly rains during the latter part of July and in August were favorable for disease development. A dry, hot spell in September seemed to check the disease somewhat for that period. As yet, no accurate correlations have been calculated.

10. There seemed no real difference in susceptibility among the commonly grown commercial varieties such as John Baer and Stokesdale. Apparently, some of the Italian types showed some tolerance.

NEW YORK STATE AGRICULTURAL EXPERIMENT STATION
GENEVA, NEW YORK, OCTOBER 17

TOMATO LATE BLIGHT IN CONNECTICUT

J. G. Horsfall

1. 2. Loss is estimated at 25 percent, on the mature crop.

3, 6. Some spraying was done with Dithane, Phygon, or Bordeaux. Very few growers attempted control measures.

8. The disease appeared here two or three weeks after its appearance in New Jersey; possibly carried up from that State.

10. New Hampshire Victor seemed less susceptible than other varieties. Vegetating plants were less affected than heavily fruiting plants.

CONNECTICUT AGRICULTURAL EXPERIMENT STATION
NEW HAVEN, CONNECTICUT

LATE BLIGHT ON TOMATO IN RHODE ISLAND IN 1946

Richard S. Davidson

The tomato late blight epiphytotic was, according to commercial growers and County Agents throughout the State, the most extensive and severe experienced in Rhode Island. The infection of tomato foliage and fruits was first observed on the 9th of August in Washington County. It was reported from every section of the State on approximately this same date. The incidence and severity of the infection on both foliage and fruits increased rapidly. This increase may be attributed to principal factors, excessive rainfall and insufficient control practices.

The average rainfall for the State during the month of August was 12.24 inches. This is the highest rainfall recorded for a similar period in Rhode Island since 1914. Approximately 75 percent of the total rainfall recorded for the month fell during the period of August 7 to 20. Between 4 and 5 inches of rainfall was recorded throughout the State on August 7, and 2 to 2.5 inches were recorded on the 19th. Rainfall was recorded on 13 days during the month of August in Washington County. The northern portion of the State had even more frequent occurrence of rainfall. An average rainfall of 1.7 inches was recorded for September with practically all of it occurring in the last half of the month. Interestingly enough, the rainfall record for September is the lowerst since 1914 for a similar period in Rhode Island.

In addition to the excessive precipitation, very few tomato growers were prepared to apply the proper control measures. This applies to the commercial growers as well as the home gardeners. Growers who were prepared found it impossible to maintain sufficient coverage to adequately control the infestation because of the excessive amount and frequent occurrence of rainfall.

According to reports received from the county agent, 70 percent of the mature crop was lost in the northern portion of the State which includes, Providence, northern half of Kent and Bristol Counties. Newport and southern Bristol counties reported a 75 percent crop loss while the greatest loss occurred in Washington County with a 90 percent crop loss.

In the case of Washington County virtually no marketable tomatoes were available after the middle of August. The remaining areas were able to salvage a very small percentage of the total crop during late August and early September.

The loss in Rhode Island occurred entirely on the mature field crop. No apparent varietal resistance was observed in any of the commercial plantings. The small-fruited plum and pear types of tomato have been reported to exhibit resistance to the late blight fungus, however, this has not been observed by this writer.

RHODE ISLAND AGRICULTURAL EXPERIMENT STATION
KINGSTON, OCTOBER 15

TOMATO LATE BLIGHT IN MASSACHUSETTS

O. C. Boyd

1. Loss estimates: 50 percent of the commercial crop and 75 percent of the home garden tomatoes.

2. The loss was on bearing plants with both immature and fully developed fruits.

3. Although many commercial growers dusted or sprayed during July and into August for control of early blight, the treatment in most instances was not frequent enough nor continued long enough to prove effective against the Phytophthora late blight. Those who did spray weekly with home-made Bordeaux throughout August and into September got almost perfect control. Bordeaux powders, neutral copper fungicides, and Dithane gave varying degrees of control, mostly poor to moderate. Some few home gardners who applied copper dusts or sprays heavily and once a week during the same period experienced very little or no losses from late blight or other foliage and fruit diseases.

4. Spraying, generally, although scattered instances were observed of both home gardners and commercial growers who controlled late blight successfully with copper dusts.

6. No more than 5 to 10 percent made a special effort to control late blight.

7. Preparations are being made for better control facilities next year.

8. Evidence (observations) points to air-borne spores from infested States, south and west of Massachusetts as the source of our initial infection -- rather than a spread from infected potato fields.

9. Late blight made most headway during the period when cool, rainy weather prevailed, and subsided when drier, warmer weather came on.

10. We did not observe varietal differences, except that the disease made considerably slower progress on vines and fruits of Dwarf Stone than on Pritchard growing in adjacent rows in a home garden.

MASSACHUSETTS STATE COLLEGE
AMHERST, MASSACHUSETTS, OCTOBER 4

LATE BLIGHT IN NEW HAMPSHIRE

M. C. Richards

(1) I cannot give you accurate estimates of losses from late blight in New Hampshire, as no survey of the State was made with respect to this disease on potatoes or tomatoes. A great many home gardeners lost practically their entire crop due to late blight on tomato fruits. We have no large commercial growers of tomatoes.

(2) The loss sustained occurred on the mature crop. In no case were the seedling plants affected.

(3) Most of the newer organic fungicides were not used by potato or tomato growers in the State.

(4) Where an efficient job of either spraying or dusting was carried out, effective control of late blight was obtained by both methods.

(6) About 10 percent of the home gardeners attempted control of late blight on tomatoes.

(7) We are not preparing to expand control facilities for next year. Some of the newer fungicides may be given a trial, however, by certain growers.

(8) There are always numerous centers of inoculation. Because of the wet, cool weather which we had in August, there was a widespread movement of spores from these centers to unprotected plants.

(9) The incidence of disease in the State this year could definitely be associated with the weather.

(10) As far as we could observe, there were no differences with respect to infection on tomato varieties.

(11) The late blight fungus was not observed on other crops, although no special effort was made to check on this point.

UNIVERSITY OF NEW HAMPSHIRE
DURHAM, NEW HAMPSHIRE, OCTOBER 14

TOMATO LATE BLIGHT IN MAINE

Donald Folsom

The following information comes from Joseph C. Hickey, Vegetable and Canning Crops Extension Specialist in Maine.

1. Loss averaged 25 to 35 percent.

2. It occurred mostly on the mature fruit, causing much late blight rot.

3. A few growers sprayed with bordeaux 2-2-50. A few dusted with a neutral copper dust. Notices of expected blight losses were sent to all growers July 26. However, many farmers did not think it would be serious and did not carry out control measures.

4. Apparently spraying and dusting were equally good, but direct comparisons were not made.

5. No airplane dusting was done.

6. Percentage of growers using control practices was 15 percent as a rough estimate.

7. The control measures for blight will be stressed in meetings this winter and timely notices will be sent out next season.

8. Dissemination was by the usual manner.

9. The early part of the growing season was dry and only a very few spots appeared to have blight started. Later on, continued rain plus several cloudy days in August caused rapid spread.

10. It appeared to me as though John Baer and Bonny Best were hit particularly bad.

MAINE AGRICULTURAL EXPERIMENT STATION
ORONO, OCTOBER 17

TOMATO LATE BLIGHT IN OHIO

H. C. Young

1. Loss is estimated at 8 percent -- 3 percent from fruit, and 5 percent from plant stand.

2. Loss was mostly from plant stands.

3. A limited amount of spraying and dusting was practiced.

4. Spraying was more effective according to results from plot tests.

5. Some airplane dusting was done and it was partially effective.

6. About 10 percent of the growers attempted control measures.

7. Expanded control facilities are being prepared for next year. (See note).

8. There are no specific observations on the manner of dissemination this season, except wherever there was heavy vine growth, the disease was more severe. It was also severe in home gardens where they were shaded or poorly air drained.

9. Exceptionally dry weather during July and August prevented spread. A dangerous situation was changed so that only a very slight loss occurred.

10. No differences were observed in varietal reactions.

As late as mid-June we thought we might lose our tomato crop from late blight but the weather changed and became dry and we had one of the finest crops ever produced in this State.

Note. -- A symposium on the late blight situation has been arranged for the Cincinnati meetings. Also special machinery is being arranged for plant bed control of the disease. Also, formulas for field spraying are being arranged.

OHIO AGRICULTURAL EXPERIMENT STATION
WOOSTER, OCTOBER 17

LATE BLIGHT ON TOMATOES IN OHIO IN 1946

Thomas H. King

Late blight was reported as present in 36 counties in the State, first making its appearance May 29 in Ottawa County on southern-grown tomato plants. On June 26 it was found in Washington County on both southern and home-grown plants. Losses ranged from 3 to 25 percent in the State as a whole with about a 3 percent loss in the tomato canning area, except for a few counties in this latter area where losses up to 25 percent occurred. However, in the staked tomato area in Southern Ohio a 20 to 25 percent loss occurred. A conservative estimate in one Southern Ohio county was that growers had lost $40,000 due to late blight.

This year late blight was injurious to the young plants at setting time, necessitating replanting or spot-planting in both the staked and canning areas. Approximately 50 percent of the fields were reset to some degree. In the cases where blight was present, but conditions were not favorable for its growth, the tomato plants were stunted and less vigorous than home-grown transplants set at a later date and also when compared with drilled fields of tomatoes.

A 7 percent fixed copper dust or a spray consisting of 4 pounds of 50 percent metallic copper to 100 gallons of water was recommended for control where there was no evidence of the disease in the field. In cases where late blight had already gained a foot-hold and was present on the fruit, an 8-8-100 bordeaux mixture spray was recommended at the rate of 300 gallons per acre to be applied in three applications at 5-day intervals. However, under Ohio conditions it is practically impossible to spray, and about 90 percent of the growers that attempted control measures used a fixed copper dust.

Some airplane dusting was attempted. In the few fields that were observed that had been airplane dusted, the disease had already gained a foothold and the application of dust was not effective in control. In some diseased fields a portion of the crop was harvested, since the blight subsided as a result of unfavorable weather conditions for the further development of the disease, rather than through the effectiveness

of the airplane dusting.

In the tomato canning area approximately 50 percent of the growers attempted some means of control. In the rest of the counties that reported late blight probably less than 10 percent of the growers attempted control.

The losses from late blight were the greatest in the staked tomato area in Southern Ohio, and in the middle one-third of the State, which embraces the lower tier of counties of the tomato canning area. The weather during the month of August was wet and cool. The temperatures in the middle one-third of the State averaged approximately 65°, which was approximately 7° cooler than normal, with normal rainfall occurring intermittently throughout the month; whereas in the northern section of the tomato canning area the weather was relatively cool, but extremely dry. Thus, although the disease gained a foot-hold in the southern portion of the tomato canning area there was no spread after the month of August.

As far as we could determine there were no differences in varietal reactions.

Although the disease is present to some degree every year it seldom causes any appreciable loss. However, we believe that the plants shipped in from the Southern States were an important factor in the epidemic of late blight this year.

OHIO STATE UNIVERSITY
COLUMBUS, OCTOBER 18

TOMATO LATE BLIGHT IN INDIANA

R. W. Samson

Satisfactory estimates of the losses caused by late blight on potatoes and tomatoes in Indiana in 1946 are difficult to make because of the erratic seasonal and geographic distribution of the disease. Temperatures were generally favorable throughout the season. Rainfall was rather frequent and abundant to about August 1 in the southern half of the State, but definitely deficient from the first of July throughout the rest of the State.

Moderate day-time and frequently low night-time temperatures resulted in many nights with heavy dews, as well as fog banks over low-lying areas. These dew and fog conditions alone did not appear sufficient to promote severe blight epidemics. Blight epidemics occurred only when the fogs and dews were supplemented by rainy periods.

The disease was positively identified on many arriving shipments of southern-grown tomato plants last spring. Subsequently, excessive stand damage, due to late blight stem cankers, was observed. This late blight stem infection was frequently co-existent with stem cankers due to Alternaria solani. Late blight on maturing tomatoes was first observed in early July on small plantings in the hilly, wooded sections of southern Indiana. Infection became rather general throughout southern Indiana in late July and early August, with severe damage in localized areas. This late blight development appeared associated with frequent rains. Some severe late blight in northeast central Indiana occurred in low-lying areas, fields surrounded by trees, or in direct-seeded tomato fields with very dense foliage cover.

Subsequent to about August 1, and earlier in northern Indiana, dry weather set in and persisted until after frost. As a consequence, an unusually good canning tomato crop was harvested over most of the State. While individual fields were almost completely destroyed by blight in July or early August, it is doubtful if as much as a ten percent loss for the State as a whole can be charged to late blight. This would include both early stand losses and subsequent foliage and fruit destruction.

Three Indiana canners undertook to spray their contracted tomato acreages and are satisfied with the results, although they admit that dry weather alone would have held the disease in check in their areas.

Many tomato growers dusted by airplane. Initiation of dusting coincided with onset of dry weather in most areas so that the effectiveness of this method could not be satisfactorily determined. Some evidence of partial effectiveness of airplane dusting was reported by one canner in southern Indiana. Six applications of around 40 pounds of a proprietary copper dust per acre were made on 330 acres in this instance.

Spraying with proprietary copper or thiocarbamate fungicides will be promoted in Indiana next year.

It seems likely that most of the late blight developing on tomatoes in Indiana this season came from the initial infection present on the many southern-grown transplants.

The development of the disease on early-spring planted potatoes in southern Indiana could have been another source, but we have no positive evidence of it. The generally more severe development of the disease in direct seeded tomato fields has been obviously correlated with the closer spacing of plants and the generally more dense foliage cover.

No differences in varietal reactions to late blight were noted. The disease was noted on pepper in one home garden.

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION
LAFAYETTE, INDIANA, OCTOBER 23

LATE BLIGHT IN ILLINOIS

G. H. Boewe

From August 26 to 30, I examined potatoes and tomatoes in the northern half of the State. I examined three fields (approximately 153 acres) of tomatoes in the southeastern part of Iroquois County and no late blight was observed. However, late blight was severe on tomatoes in the south part of Vermilion County, approximately 40 miles south. Septoria leaf spot had caused severe defoliation in fields set with plants that were brought in from Southern States.

On October 10, I examined potatoes and tomatoes in Jo Daviess County (northwest corner of the State). There had been very little rain in that area for three weeks. Tomatoes in a garden near blighted potatoes were severely diseased. The foliage on some plants was almost all killed by late blight and approximately 60 percent of the fruits were infected. The fungus was fruiting abundantly on foliage and fruit of tomatoes.

I will answer some of the questions which you submitted by number.

1. Tomato losses due to late blight are estimated at 0.5 percent of the crop.

2. Loss occurred on the growing crop before maturity. In southern Illinois, blight became severe before the first tomatoes were ready to pick. However, I saw some late blight on tomato plants in one plant field in Pulaski and Monroe Counties.

8. In the northwest part of the State late blight spread from potatoes to tomatoes in garden.

9. In southern Illinois where late blight occurred on tomatoes and potatoes in May and June, the progress of the disease was stopped by warm, dry weather of June and July. In the northern part of the State, late blight came in late because of the warm, dry weather in July. The following table gives the average total rainfall and average mean temperature of three stations in southern Illinois (Cairo, Anna, and East St. Louis) and of two stations in northwestern Illinois (Freeport and Mt. Carroll).

	3 Southern Stations		2 Northern Stations	
Month	Average mean temperature	Average total of rainfall in inches	Average mean temperature	Average total of rainfall
April	61.7	2.86		
May	62.8	8.16		
June	76.5	2.29		
July	79.5	3.09	73.0	0.90
August			68.7	4.28

ILLINOIS STATE NATURAL HISTORY SURVEY
URBANA, OCTOBER 19

TOMATO LATE BLIGHT IN ILLINOIS

M. B. Linn

1. The losses from late blight for the State as a whole were probably less than 1 percent since only two general areas involving around 1200 acres were affected. The loss in these areas was from 5 to 7 percent.

2. Loss was mostly on vines with green or ripe fruits.

3. Dusts were used almost exclusively. These were fixed-copper dusts with around 6 percent metallic copper and applied with peach dusters and by plane. One small grower in the southern part of the State used 5-5-50 Bordeaux mixture.

4. No direct comparisons were possible between spraying and dusting.

5. Airplane dusting is believed to have checked appreciably the spread of the late blight fungus. Coverage of fruit with dusts was good under rather heavy foliage at a distance of 25 feet from path of plane. Where planes were used, two applications were made.

6. Probably around 1 percent of growers in the State attempted control measures.

7. Thus far we have made no plans for expanded control facilities for 1947. Ground equipment for use in tomato fields is limited but there would be little trouble in obtaining planes for dusting. We are somewhat dubious about the use of plane dusting in the neighbor-of the large cities, e.g. in the greater Chicago area.

8. No specific observations were made on dissemination.

9. When rains ceased in the East Central Part of the State in September, there was a cessation in development and spread of the late blight fungus. Had this not happened losses would have been nearly 75 percent instead of five percent.

10. Garden State was affected more severely than Early Baltimore and Rutgers in same field. No claims are made regarding susceptibility. We are reasonably sure that Garden State is no more resistant than the other two varieties named, however.

UNIVERSITY OF ILLINOIS
URBANA, OCTOBER 11

WISCONSIN

R. E. Vaughan

1. No estimates of loss can be made for Wisconsin. Many irrigated fields gave a very poor crop. Commercial fields in Southeastern Wisconsin were not affected.

2. Losses were noted mostly on the mature crop.

3. No control measures were taken.

6. As far as we know no growers attempted control.

7. At present we are not preparing expanded control facilities.

9. We have no observations on effect of weather. The first specimens were brought in August 30.

UNIVERSITY OF WISCONSIN
MADISON, OCTOBER 8

TOMATO LATE BLIGHT IN MINNESOTA

E. C. Stakman

The following memorandum was prepared by Dr. C. J. Eide and Mr. R. C. Rose.

1. From reports by growers, I would estimate a loss of yield of 10-20 percent of the tomato crop.

2. Loss occurred on fruit in the latter part of the season. The disease was just reported about August 15.

3. No control measures were used as this was the first year blight has been severe on tomatoes, and most growers do not find it pays to spray or dust for <u>Septoria</u> leaf spot or <u>Alternaria</u>.

4. Neither spray nor dust were used enough to tell which was better.

5. No airplane dusting was used.

6. Only a fraction of the growers used fungicides.

7. I believe the extenion pathologist (R. C. Rose) plans to recommend

fungicides next year.

8. No observations were made on methods of dissemination. Infection was widespread.

9. Because July and August were very dry, the disease was found first only in gardens or commercial fields where overhead irrigation was used.

10. No differences in varietal reaction were observed.

11. No blight was observed on hosts other than potato and tomato. There was relatively little blight on potatoes, except for fields on peat. (Blight from tomato infected potato tubers and vice versa in limited laboratory tests)

UNIVERSITY OF MINNESOTA
UNIVERSITY FARM, ST. PAUL, OCTOBER 17

TOMATO LATE BLIGHT IN IOWA

W. F. Buchholtz

1. Loss was estimated at 15 percent on tomatoes.

2. Loss was to the tomato fruit crop just as harvest season was about to begin. Afflicted fields were a total loss.

3. No control measures were used on tomatoes.

7. Our commercial tomato growers will probably spray or dust in 1947.

8. On tomatoes, P. infestans appeared first and most severely on southern-grown (Georgia) plants. Ultimately it spread to home gardens and commercial fields grown from seed. It was observed on potatoes after it had been found in abundance on tomatoes!

9. Cool, wet weather during one week in mid-August was enough to facilitate complete destruction of the tomato crop in afflicted fields.

10. No varietal differences were observed.

IOWA STATE COLLEGE
AMES, OCTOBER 21

COLORADO

W. D. Thomas, Jr.

Late blight on tomatoes appeared very late in September in Adams, Weld, and Larimer Counties. However, these infections were slight and widely scattered, apparently as a result of inoculum blown in from nearby potato fields or garden plots.

COLORADO A & M COLLEGE
FORT COLLINS, OCTOBER 17

WASHINGTON

M. R. Harris

The late blight fungus was present in the Yakima Valley on tomatoes only to a very slight degree. I did find a field of tomatoes on the coast in Whatcom County not far from Bellingham that was severely affected by late blight. In coastal areas the disease exists but growers in that part of the State are accustomed to practice control measures and I did not see any fields there that showed more than an occasional trace.

STATE COLLEGE OF WASHINGTON
PULLMAN, OCTOBER 16

SOME NEGATIVE REPORTS

MISSOURI

By C. M. Tucker

We did not encounter late blight on tomatoes in this state during the past season. Niether did we find it in 1945 when we experienced our first outbreak of the disease on potatoes. This may have been because of the fact that our potato crop is harvested early, and warmer weather later in the season was not favorable to the development of the disease on tomatoes.

Our 1946 season was very warm and dry during July, and the temperatures during August and September were not low enough to permit the development of the disease on tomatoes.

UNIVERSITY OF MISSOURI
COLUMBIA

ARKANSAS

By V. H. Young

We have no reports of late blight on either tomatoes or potatoes and the Plant Board has no record so far as I can find of diseased plants shipped in.

My feeling is that it becomes hot and dry here too early for the disease to obtain foothold.

UNIVERSITY OF ARKANSAS
FAYETTEVILLE, OCTOBER 11

NEBRASKA

By Arden F. Sherf

Late blight on either tomatoes or potatoes has not been a problem in Nebraska this year. We have had no reports of tomato late blight. Tomatoes are only a minor crop here.

UNIVERSITY OF NEBRASKA
LINCOLN, OCTOBER 16

OKLAHOMA

By K. Starr Chester

I have your request for information on late blight of tomatoes and potatoes. This disease is very rare on either host in Oklahoma. There have been no reports or findings of late blight in this State during the past season nor, indeed, do we have any authentic records of late blight in Oklahoma in past years.

A possible explanation is the fact that our potatoes and tomatoes become mature during a period of very high temperatures, often 90-100° or even higher temperatures that are quite unfavorable for late blight development. In contrast, these crops when grown in the North, mature at a time of falling temperatures, while in the deep South they are grown as winter crops under cool conditions. In both of these cases the temperatures are favorable for late blight.

Under these conditions control measures for late blight are not recommended in this State.

UNIVERSITY OF OKLAHOMA
STILLWATER, OCTOBER 5

TEXAS

By P. A. Young

My answer must be "No" to all of the questions, because I did not see (or hear of any) late blight on tomatoes or potatoes in East Texas this year. More plants were brought here from the Lower Rio Grande Valley again last March, but there was enough dry, warm, windy weather last spring to control late blight. I had warned them to get plants only from healthy fields.

TOMATO DISEASE LABORATORY
JACKSONVILLE, OCTOBER 9

ARIZONA

By J. G. Brown

Late blight was not observed nor have any complaints come in. It is usually unimportant in this State.

UNIVERSITY OF ARIZONA
TUCSON, ARIZONA

IDAHO

By C. W. Hungerford

No late blight in Idaho.

UNIVERSITY OF IDAHO
MOSCOW, IDAHO

ACCOUNTING FOR THE BEHAVIOR OF TOMATO LATE BLIGHT IN MASSACHUSETTS IN 1946

Oran C. Boyd

(Reprinted from: "The Commercial Vegetable Grower", October, 1946)

Twice before in Massachusetts, in 1905 and 1932-33, the late blight disease of tomatoes assumed epidemic form and caused heavy losses in home gardens and commercial fields. In 1932, it even spread to and greatly damaged a great many fall greenhouse crops of tomatoes in eastern Massachusetts before the heating season started. This year, scarcely a garden or field in Massachusetts escaped damage. Losses varied from light to complete, depending mostly upon the time of setting the plants, whether or not they were trained to stakes, trellis, etc., and the amount of protection with fungicides.

In 1932-33, the tomato late blight outbreak occurred in New England, with the most pronounced damage being in Connecticut, Massachusetts, and Rhode Island. This year, the outbreak in New England merely represented an aftermath or continuation of a similar situation that covered all the Eastern States from Florida to New York State and as far inland as Tennessee, Kentucky, Indiana and Illinois. In general, however, the greatest damage occurred in States along the Atlantic coastline together with the adjoining States and the New England States.

Relation to Potato Late Blight. Late blight of tomatoes is caused by the same fungus, *Phytophthora infestans*, that causes the common late blight and tuber rot disease of Irish potatoes. The question then arises, why does the disease behave so differently on tomatoes than it does on potatoes? Practically every year late blight is present on potatoes in Massachusetts, causing moderate to heavy damage in unsprayed gardens and fields, particularly in the late maturing varieties. Yet, under the same growing conditions, late blight ordinarily attacks tomatoes either very lightly or not at all, even when no fungicidal treatments are given; or when the disease is severe it is very spotty in distribution and develops late in the season usually after the first of September.

A few years ago plant pathologists in New York State demonstrated beyond doubt that although the tomato blight fungus is the same species as the one causing potato blight, two different strains of the species are involved on the two crops. The ordinary potato blight fungus is not capable of spreading from potatoes to tomato plants and causing anything but very light infection with only slight or no damage. In other words, tomatoes are quite resistant to potato late blight and will not become damaged by that disease organism except after certain conditions have prevailed. It was found, for example, that when the

potato blight organism was permitted or compelled to develop seven or more successive "broods" or generations on tomato plants, it gradually became adapted to the tomato plant and was then capable of causing typical severe damage to tomatoes. Furthermore, this resulting tomato strain of the late blight fungus retained its virulence for attacking potatoes; and it would remain the tomato strain even after growing continuously on potato foliage for three months or on potato tubers for six months.

In other words, it is possible for the potato late blight fungus to assume additional parasitic properties for the naturally resistant tomato plant provided weather conditions are favorable for seven or more successive passages of the fungus through the tomato plant. The minimum time that will permit one complete passage, that is, the infection of the tomato leaf or fruit, the formation of the lesion, and finally the production of spores on that lesion, is about three days. Hence, even when the most favorable weather conditions prevail continuously, that is, cool wet nights, and warm, dry or wet days, the shortest period of time required for building up a tomato strain of the fungus from potatoes would be around three weeks. But since it is likely that unfavorable weather would occur at one or more places in the series of seven successive "broods", the formation of the tomato strain may never be completed or it would be delayed well beyond the minimum 3-week period, probably not before an early-planted tomato crop matured or a late crop is killed by frost.

Hence it is not surprising why in some seasons tomatoes growing along side blighted potatoes remain uninfected or at least undamaged. It is also thus explainable why the same weather conditions that may contribute to rapid and complete blighting of potato vines may not "cause" adjacent-growing tomatoes to blight down.

In most years, scattered cases of late blight may be found on tomatoes in Massachusetts, most likely near the coastline in Bristol and Plymouth Counties and in the Connecticut Valley. But in those instances it shows up late in the growing season, usually a month or more after the appearance of late blight on potatoes in the same sections. The delayed appearance of the disease on tomatoes might well be explained by the time required for the fungus to convert itself from the potato strain to the tomato strain of the blight organism.

Source of the Outbreak in 1946: This year late blight "struck" tomato gardens and fields in Massachusetts at the same time the disease appeared in widespread form on potatoes. It is true that a very few isolated potato infections were observed in Plymouth and Bristol Counties before mid-August. However, not until August 15-20 did the disease become widespread in any part of the State on potatoes in unsprayed and poorly protected fields. The first observations of late blight on potatoes and tomatoes in the extensive Connecticut Valley

were made on August 20. All cases represented early stages of infection, and those in tomato gardens and fields were in most instances independent of infected potato plantings. In addition, it was apparent from the heavy localized infections on tomato plants with profuse sporulation on the diseased leaves, that the virulent tomato strain of the fungus was present at the very outset of those infections.

This situation suggests that the tomato strain of the late blight fungus was introduced into the State from some outside source and then developed rapidly on tomatoes simultaneously with the development of the potato strain on potatoes. Or, it could be that much of the blight on potatoes was due to the tomato-strain organism. The "outside source" for the fungus on tomatoes might readily have been air-borne spores from the heavily infected tomato fields in States located southwest of New England. There was little or no opportunity for the organism to be introduced here on southern grown plants since it is the practice in Massachusetts to use only home-grown plants.

It doesn't seem far fetched to assume the air-borne mode of entry, particularly this year, since downy mildew of cucumbers and melons is believed to reach this area each year only by way of spores blown during wet periods from States farther south and southwest of us. The weather during August in most or all of the Eastern States area was marked by cool, wet periods of sufficient duration and wind direction to favor dissemination of fungus spores over long distances. It is assumed that the tomato blight fungus was introduced in that manner and then found ideal conditions afterwards for rapid spread within the State.

<u>August Weather</u>: One reason for the rapid progress of late blight in tomato gardens and fields was the unusually cool damp weather during August. Another reason is the general failure to spray or dust tomatoes during August and September to the extent that potatoes are protected. In Bristol County, more than 12 inches of rain fell during August, about four times the normal amount. At Amherst, the total precipitation for August was hardly normal, yet there were 15 days when rain fell, as compared with a normal of 11 days; a mean cloudiness of 67% compared with the normal of 49.7%; and a mean daily temperature almost 2° below normal. The mean minimum and maximum temperatures for the last seven days of August were 50.0° and 76.3° F., respectively--conditions highly favorable for the late blight disease.

<u>Control</u>: The only instances of satisfactory control of late blight of tomatoes this year in either home gardens or commercial plantings involved copper dust or spray applications at 7 to 10 day intervals from late July or early August right through August and September. In general, spraying was more effective than dusting, and the most effective jobs of spraying involved the use of homemade Bordeaux mixture. Growers along the eastern shore of Plymouth County who spray their

tomatoes regularly every year for this disease, obtained almost perfect control where applications of Bordeaux mixtures were made at weekly intervals throughout August and into September.

MASSACHUSETTS STATE COLLEGE
AMHERST, OCTOBER

CUSTOM SPRAY RINGS USED TO CONTROL LATE BLIGHT ON TOMATO

L. O. Weaver and O. D. Burke

An attack of late blight in August and September 1945 caused tomato growers in Northern Luzerne County, Pennsylvania, to plan a spray program for the 1946 season. Tomato spraying was not the custom, machinery was non-available and spraying methods and materials not well established.

However, the following decisions were made and carried out:

(1). The planting distances were changed so that spraying could be done effectively and with a minimum of injury by equipment. Six feet between rows was the new standard planting distance with 2 1/2 to 3 feet in the rows.

(2). Tractor mounted sprayers were used. The sprayer straddled one row and sprayed two additional rows on each side of the machine. A boom arrangement was developed similar to the conventional type of potato spray boom but with nozzles according to diagram. (Figure 1).

(3). Bordeaux mixture 6-3-100 was used in spite of reports that this fungicide injured blossoms and reduced yields.

(4). The fields were to be sprayed by custom spray ring. The price for spraying varied from $2.85 to $3.00 per acre per application.

Growers who experienced no trouble with late blight in 1946 started spraying two to three weeks after the plants were set and continued applications at 7-day intervals during the entire season. In some cases, 12 or more sprays were applied. Weather conditions were very favorable for Phytophthora infestans. The yields this year have been the largest ever produced. Many growers have reported ten tons per acre of green-wrap tomatoes where Bordeaux 6-3-100 was applied all season at weekly intervals. Fields not sprayed were severely blighted on August 8, 1946.

Luzerne County Agent Mr. J. D. Hutchison, hopes that the spray ring operators may be able to purchase additional equipment as the

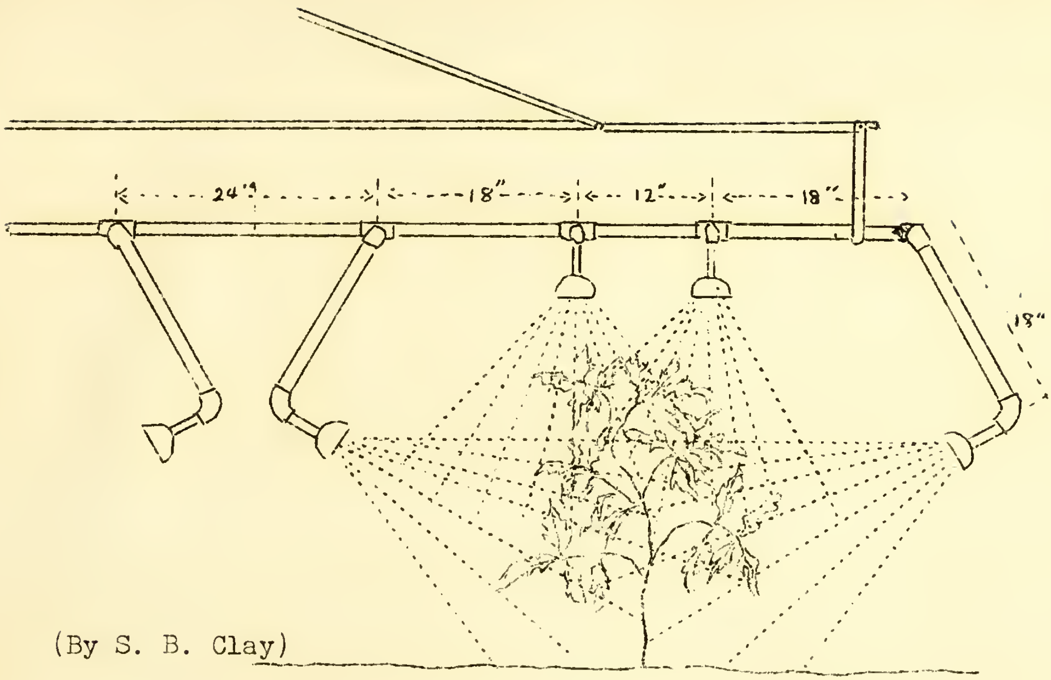

Figure 1. Boom arrangement used for tomato spraying in Pennsylvania

growers feel the spraying of tomatoes to be a very efficient farm operation. The growers who planted rows six feet apart are unanimous that they will not plant closer in the future since this distance provided good spraying conditions and also aided considerably in providing more room for pickers to walk and place baskets.

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Report of the Vegetable Seed Treatment Sub-Committee of the Seed Treatment Committee of the American Phytopathological Society, C. M. Haenseler, Chairman. Reports compiled by various authors; see its table of contents, and author index below.

Supplement 162. A contribution to the fungus flora of Utah and Nevada. pp. 67-99. June 15, 1946. By Arthur S. Rhoads
Fungi listed alphabetically under Phycomycetes, Ascomycetes, etc. Only host and fungus genera listed in the following index.

Supplement 163. Rootrots and leafspots of grains and grasses in the Northern Great Plains and Western States. pp. 101-268. June 15, 1946. By Roderick Sprague.
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Supplement 165. The 1946 epiphytotic of late blight on tomato. pp. 297-345. November 15, 1946.
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